THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE

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TRAMWAY FINANCE.

THE position of many of the electrical tramway undertakings in the United Kingdom cannot be regarded with much satisfaction. The margin of returns over expenses is too small to permit of reasonable dividends being paid. It is probably true that as regards shareholders, dividends have to be paid on amounts of capital very largely in excess of the cash expenditure on the undertaking. The excess of nominal capital represents the initial expenses connected with promotion, or with those payments to which promoters consider themselves entitled, in return for the work done up to the time when the shareholders have been induced to take the burden off the shoulders of the promoters.

The question of sinking fund is ever a vexed one. Where an undertaking is capitalised simply on its net cost, as in the case of a privately-owned factory put up by a man who knows his business, the sinking fund is probably placed at, say, 5 or 10 per cent. on such cost. By sinking fund is meant to be included depreciation. The amount of such fund should be such that when the plant represented has sunk to scrap value, the fund will be equal to the initial cost, and capital will be to hand to make a fresh start. In the case of a tramway undertaking costing £100,000, but capitalised at £200,000, the setting aside of sufficient to give back the latter sum to the shareholders may be difficult. To give back the actual cost, however, might be managed. If all the tramways in the country were to be examined in this light, it would probably be found that they could be made to pay all standing charges, and to return a fair profit, whereas on their present watered capital this cannot be done.

The costs of tramway undertakings are very great. Repairs are heavy; they do not become lighter, but, as machinery becomes older, they tend to increase. Tramcar machinery has to a large extent taken its form from American models. The adaptation of unalloyed American methods to English practice has not been altogether successful.

From an inspection of a few lines at work, it would appear that success can only be anticipated where the traffic is such as to require frequent service. A thin service cannot hope to pay, because the interest charges on the track are spread over too small a number of passenger miles. Mere summer holiday routes also will not do well, because their earning period is limited to a few weeks only, and during those few weeks a single track cannot possible carry the traffic which offers. The electric tramcar is the vehicle for heavy constant traffic. On light traffic its permanent way costs and its station costs are much too large.

The older lines in the country have now been at work something like four years, and repairs and maintenance are becoming heavy. Officials are beginning to find that the working results of the first year or two must not be taken as a sample for future guidance. They are

finding that the methods of construction have made for extensive maintenance, and that early methods founded on what was made to do in America, are bad in principle and worse in practice. What can be worse, for example, than the working pinion on the motor shaft! Is it good practice to place these pinions so that all the wear of a motor shaft is put upon one bush bearing? As the bearing wears, the shaft is thrown to an angle out of parallel with the main axle, and obviously the pinion must wear all at one end. Many other obviously weak points crop up, and there are some engineers who demand a careful reconsideration of the whole design of cars and car machinery, for it is unlikely that real success can be attained unless the maintenance charges are kept down to a reasonable figure. How little has been done to set aside funds to meet the inevitable, when the undertaking is taken over at the "then value!"

Glasgow Municipal Telephone System.

In another column we publish an article on "Municipal Telephony" dealing with a series of articles recently published in the *Electrical Engineer*. Our contemporary shows such scant knowledge of the subject that it would be waste of words for us to reply in detail to the many erroneous assumptions in which it indulges, as it would also be to resent seriously the numerous charges of bad faith against this paper—a style of controversy happily unusual in the technical press. But in the concluding article of the series the *Electrical Engineer* alleges that those interesting themselves in municipal telephony are not receiving fair play, and on that point we have a word or two to say. Presumably any body of men who have their mistakes brought home to them, and their attempts to conceal them exposed, will complain to their sympathisers that they are not receiving fair play.

What are the facts regarding municipal telephony? For years "those interesting themselves in municipal telephony" have preached to the municipalities that they could operate telephone systems at such figures of cost that a rate for service of about £5 would yield a gross revenue of 25 to 30 per cent. on the capital invested. At the Glasgow Telephone Inquiry of 1897, Mr. A. R. Bennett put in an estimate for a "Glasgow Municipal Exchange," in which the capital expenditure was to be £97,833 3s. 8d., and the gross revenue £27,550, equivalent to a gross revenue of over 28 per cent. on the capital. All criticisms on this estimate were waived aside. Was it not backed by tenders from responsible firms, and had not the Corporation received numerous applications for the service? A few years later the Glasgow Corporation proceeded to build a telephone system under Mr. Bennett's guidance, and though the end of capital expenditure is by no means in sight, as £50,000 more is urgently demanded, there is now invested in that system over £318,000, earning a gross revenue of about £50,000. The gross income, then, is less than 16 per cent. on the capital, instead of the 28 per cent. shown in the estimate. If a gross income of 28 per cent. was estimated to be required, and only 15 to 16 per cent. is actually received, what results?—A variety of manœuvres in order to show a success on paper, for municipal trading must show such a success.

We fail to see that there is any lack of fair play in exposing these errors. Mr. Bennett's estimates of what municipal telephony could accomplish were agreed with, so far as we are aware, by no other telephone expert. The results have proved Mr. Bennett wrong. So much the worse for Mr. Bennett. But in what way is fair play violated by showing that the tangible results prove that estimates always held to be unreliable by the majority of expert opinion really were unreliable? There is, it seems to us, another aspect of this form of municipal trading in which fair play may properly be considered wanting. If a municipality sells a service at less than cost price in competition with private enterprise, that certainly cannot be considered fair play. There is practically no limit to the amount of public money which a Corporation like that of Glasgow can pour into a scheme, whether profitable or unprofitable. But private capital is necessarily governed by commercial laws. There is practically no limit to the influence that a powerful trading concern like the Glasgow Town Council can bring to bear on private citizens in pushing a scheme in which its pride is embarked. Here again private enterprise is at a disadvantage. Under these circumstances, it is greatly to the credit of private enterprise, in our humble opinion, that in the telephone competition in Glasgow, the National Telephone Co. has a long lead over the Corporation, is giving the better service, and is increasing its hold on public favour, in spite of the competition of the Corporation.

The Medical Application of Radium.

According to Dr. Merz, in the *Electro-therapeutist*, there are two methods of applying radium in the treatment of disease, the choice depending largely on the nature of the disease to be treated, and on its anatomical location. In one method, 10 milligrammes of radium bromide of about 500,000 radio-activity is enclosed in a metal case, the bottom of which is a disc of lead from $\frac{1}{10}$ to $\frac{1}{4}$ in. thick, and the top a disc of aluminium $\frac{1}{100}$ in. thick. The outside of the case is screwed for the attachment of a flexible wire holder, by means of which the case can be inserted in the throat, the nostrils and other cavities. It is well to begin with exposures of a minute or two minutes, and gradually prolong the time of exposure, when it is discovered that no injurious burning effects are produced on the tissues. It must not be forgotten that these effects may not appear till about two weeks after the exposure. It has been recommended by some that radium of 7,000 activity in larger quantities, say, 30 to 50 milligrammes, should be used to reduce the danger of burning. The method which Dr. Merz prefers is the use of radio-active solutions. He has found by experiment that a saline solution is the best. In the preparation of this solution, a tube containing 10 milligrammes of radium is suspended in the centre of a pint bottle of salt water (6 gr. to the ounce), and allowed to remain there for 48 hours to 72 hours. The tube is kept floating on the surface of the solution. The radio-active solution thus produced is to be taken in teaspoonfuls, three times a day. The solution has been used in gastro-intestinal inflammation with excellent results. Compresses wet with the solution, when applied over extensive surfaces, give immediate relief in the case of malignant disease, and have a marked antiseptic effect.

The Accuracy of Modern Measurements.

The paper read by Mr. Morcom at Birmingham last month, of which we publish an abstract in this issue, together with the extremely practical discussion, affords clear evidence of the importance attached to minute accuracy of measurement in modern engine works. Even the indicator, the time-honoured guide and friend of the steam engineer, is subjected to adverse criticism on the score of the thickness of the line traced by the pencil or style, which might conceivably lead to the rejection of a steam engine as falling short of the guaranteed efficiency. Splitting hairs, therefore, is no longer to be regarded as a useless occupation.

The importance—we might almost say the necessity—of at least a moderate degree of superheat was well shown both in the paper and in the discussion. The peculiar property of superheated steam in the reduction of leakage was strongly emphasised; this applies not only to the valves and pistons of the engines, but also to the joints in the steam pipes themselves.

One remark of Mr. Morcom's deserves more than passing notice—namely, his reference to the mass of information and experimental data lying buried, we fear in many cases for ever, in the records of the testing departments of large engineering works. It is too much to hope that such collections will ever become accessible to outside investigators, and too often, through lack of time or inclination on the part of their possessors, they are allowed to pass into oblivion unused. If any system whereby they might be more fully utilised could be devised, there is no doubt that immense benefit would be derived therefrom by the engineering profession in general.

THE LABORATOIRE CENTRAL D'ELECTRICITÉ AT PARIS.

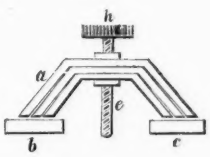
By ALBERT CAMPBELL, B.A.

The laboratories of Paris are of great interest, not only to scientific men but also to practical electrical engineers. Quite recently I visited a number of these laboratories, and I look back with the greatest pleasure to the kind and hospitable reception I had in all of them. I think some of the readers of this journal will be interested in a short description of some of the things I saw in the "Laboratoire Central," the main public laboratory for electrical testing work; I shall dwell mainly on points which struck me as novel.

The laboratory was founded in 1888 by the Société Internationale des Electriciens, and up to the present about £20,000 has been expended on it, the necessary funds coming from the profits of the Electrical Exhibition of 1881, aided by subscriptions from the leading electrical firms of France. The object of the founders was to afford the manufacturers and the public an independent tribunal for the testing of all kinds of electrical apparatus. The laboratory is under the control of a committee which at present includes a large number of the most eminent scientists and electrical experts of Paris. It is directed by M. Janet, ably supported by MM. Laporte, Durand and David. Although not directly supported by the State, it has official recognition, and is frequently made use of by State departments.

To commence with the sources of electrical energy, the laboratory has an available supply of alternating current (42 cycles per second) from the public mains in addition to a private installation of steam engine, gas engine, and five batteries of accumulators of various kinds. The general switchboard is of white marble and is arranged, as is desirable in all laboratories, on the "rectangular co-ordinate" plan with vertical and horizontal bars, so that any sink of energy may be connected to any source. For making these connections contact pieces much more elaborate than the usual screw plugs are used. Fig. 1 gives an idea of these.

Fig. 1.



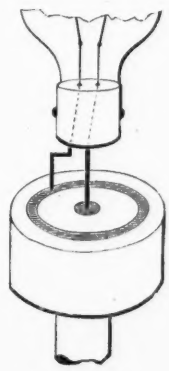


Fig. 2.

The connecting piece, *a*, is made of springy copper well laminated, as some switches are. It is removable from the board and carries a spindle, *e*, with a special quick screw arrangement. To make connection between *b* and *c*, *a* is placed in position upon them; then a very slight turning of the knob *h* is all that is necessary to bring the brush ends of *a* down against *b* and *c* with a good rubbing contact. There are projections on *b* and *c* to prevent *a* slipping round out of position. The section of copper used is large, and I was informed that this form of contact gives excellent results with very large currents.

The testing work is carried on in a series of rooms, each of which is specially fitted out for a particular division of the work. In the room for the calibration of direct-current instruments, currents from 5 to 3,500 amperes (by $\frac{1}{10}$ths) can be quickly obtained from large cells. The system of regulation is very simple and effective, consisting of a set of 40 resistances graduated in suitable steps. There is a knife switch in series with each, and, by means of these switches, resistances can be put in parallel to give any current required. The steps are so well chosen that the current can be set with ease and rapidity, and the parallel system allows each resistance to be always worked at its maximum current-carrying efficiency.

In one of the alternating-current rooms are a series of wattmeters and Kelvin balances. As I have on more than one occasion (*Phil. Mag.*, September, 1896, and *Journal Electrical Engineers*, April, 1901), advocated the use of transformers for the accurate measurement of large alternating currents, I was pleased to find that after careful and thorough investigation (Iliovici and Janet *Bulletin Soc. Int. Elect.*, February, 1903), the method has been adopted in the Laboratoire Central. Small iron-ring transformers

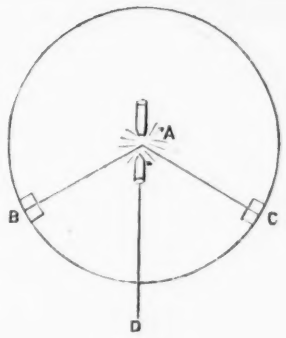


Fig. 3.

are used, and, within the limits required, the results are found trustworthy. In the high-resistance department there is a 1,000-volt battery of small accumulators for insulation tests. For tests of dielectric strength there are four large 5-KW. transformers, each giving 15,000 volts. These are immersed in separate tanks of vaseline, and by connecting their secondaries in series 60,000 volts is obtained. A Kelvin attracted-disc voltmeter is used to measure the high voltage, but as this sparks across at 33,000 volts, the higher voltages have to be measured by assuming the ratio of transformation to be constant.

In the iron-testing room two points struck me; the first was that the rings used in the ballistic method were of unusually large size, being 30 cm. in diameter and some 9 sq. cm. in cross section. By using *very thick* "flexible," the labour of winding is much reduced, but, of course, larger magnetising currents have to be dealt with. The second point of interest was the ballistic galvanometer (by Carpentier), which was correspondingly massive, having a moving coil of huge dimensions, about 15 cm. × 8 cm. (6 in. × 3 in). The galvanometer is amply sensitive for its purpose, and the large size of the moving coil makes it possible to have a very long period of swing—a great advantage in ballistic work. In the low resistance room the standard $\frac{1}{10}$th ohm is obtained by putting ten 1-ohm coils in parallel, a convenient mounting for this being Carpentier's.

In the photometric department much careful work has been done. Although the Carcel is still in evidence as the legal standard, the working standards have for many years been properly aged glow lamps (of ordinary size). In order that these standards may be easily changed and set in the right position on the photometer bench, the mounting shown in fig. 2 is used.

The terminals of the lamp consist of two stiff wires, one of which is axial; these wires stand in mercury pools sunk in the widened wooden top of the supporting pillar at one end of the photometer bench. The mercury pools serve to carry the current to the lamp, and give contacts of negligible resistance. As the outer pool is an annular channel, the lamp can be turned about the vertical axis. In order to be

able to replace the lamp always in the same position, a horizontal scale is mounted on the wall behind the photometer, and a note is taken of the position of one of the most distinctive bright or dark streaks in the light cast by the lamp. Of each batch of lamps sent for test, one is always retained by the laboratory, and preserved for future reference.

In another room are very complete arrangements for testing arc lamps and carbons. For obtaining the curve of distribution of illumination in a vertical plane, the arc A (fig. 3) is placed at the centre of a large vertical circle (about 6 ft. in diameter), and on this circle slide two mirrors, B and C, geared together in such a way that A B and A C (on opposite sides of the arc) are always equally inclined to the vertical, A D. The mirrors are set so that the light from both falls on the photometer screen. Thus, as the resultant illumination always comes from the two opposite sides of the arc, the usual troubles due to the rotation of the arc are ingeniously avoided (or at least much reduced). In the same room is a Blondel lumenmeter by which the mean spherical candle-power of an arc can be conveniently determined.

In conclusion, I may remark that there is no doubt that the Laboratoire Central has efficiently fulfilled the purposes for which it was founded; and the public are appreciating more and more the importance of careful testing work, for the work of the laboratory shows steady growth, the annual number of tests having increased from 73 in 1888, to 952 in 1899.

MUNICIPAL TELEPHONY.

"If an engineer estimates for certain work, and in the end the work is of a different character, is the original estimate to be held to hold for the altered work which was never under consideration?" This gem of English composition occurs in the *Electrical Engineer* for February 26th, 1904, page 340, and may appropriately form the text for a few remarks on municipal telephone estimates and municipal telephone results. In the course of a series of four articles, concluded in its issue for March 18th, the *Electrical Engineer*, dealing with "Municipal Telephones," does us the honour to criticise some articles published in the Review in October, 1903. Those interested in telephony will derive some amusement from the late issues of the *Electrical Engineer*, for, frankly, we can congratulate our contemporary neither on the lucidity of its style nor on its grasp of the subject. A large part of its somewhat belated criticisms of our articles of last year is marred by the violent invective seemingly inseparable from pro-municipal contributions to the technical press, and much of the rest is obscure in meaning from a lack of knowledge of the subject and an incoherency of expression which at times become simply exasperating.

We will pass over the amenities reflecting on our experience and good faith—suffice it to say that the *Electrical Engineer* contributors, in the graceful language not unfamiliar to those who have followed the municipal telephone question, accuse us of being both ignorant and dishonest. It is well known that everyone who does not believe in the current brand of municipal telephony *is* ignorant and dishonest. That is another of the cardinal principles on which municipal telephony rests, and it is not worth while to bandy words on the point. At this date we need hardly waste space in defending, or re-writing, our articles of last October. They were based on the official accounts and statistics (published by the Corporation of Glasgow), and the figures were accurate throughout. They showed that the actual capital cost of the Glasgow Corporation telephone system had largely exceeded the estimated cost, and that the original estimates, on which the whole municipal telephone agitation was based, had been completely falsified by the results. Our contemporary says that we err in making the statement that "the cardinal principles on which municipal telephony rests are that the average capital cost of a working subscriber's line in a modern telephone system is about £20, and that an average annual rate of about £5 is sufficient to pay . . . . all charges incident to the conduct of a city telephone exchange system." Our contemporary politely says that this statement is absolutely untrue, that a person is being attacked, not a principle. A little further on it says that "the only question a municipality troubles about is whether it can do the work more cheaply than a private adventurer."

This last remark, not very elegantly expressed, as the slur on private enterprise comes ill from a technical journal which lives by private enterprise, seems to bear out our contention. We were not discussing municipal trading in general, but municipal telephony, and municipal telephony *does* rest on the theory that £20 (or less) capital cost per subscriber's line, and £5 (or thereabouts) average annual revenue per subscriber's line were the figures on which municipalities could safely rely in establishing a telephone service in large cities. If the estimates had been, say, £30 for average capital cost and £7 10s. for average revenue, it is safe to say that, as these figures are so little below general practice, the municipalities would never have been tempted into the telephone business. Therefore it is not stretching the use of words unduly to say that the cardinal principles on which municipal telephony rests are that large cities in Britain can be telephoned at an average capital cost of £20 per subscriber's line, and that the system will pay all expenses at an average revenue of £5 per subscriber's line.

Since the *Electrical Engineer* so bluntly accuses us both of ignorance and of bad faith, we will elucidate the matter a little further. For the past nine or ten years the public has been assured by Mr. A. R. Bennett that large cities can be telephoned at a capital cost ranging from £15 to £20 per subscriber's line. In the earlier days of his agitation for municipal telephony, Mr. Bennett put the cost for cities such as Edinburgh at £15 a line, and for large cities, such as Glasgow and Manchester, at £16 a line. In none of his estimates, although the figure has gradually gone up, has it exceeded £20 a line. All of these estimates mention specifically a subscriber's line, not an "instrument" or "station," as the unit of cost. Our contemporary accuses us of wilfully confusing the issue as to the distinction between lines and instruments. As a matter of fact, our articles of October last cleared up the confusion between lines and instruments which had been created by the municipal telephonists using the term instrument as synonymous with line. All Mr. Bennett's municipal telephone estimates were for so many subscribers' lines. In the actual systems a large proportion of the lines have two or more instruments attached to them. Mr. Bennett and his friends now argue that the average capital cost *per instrument* is the figure which should be set against the estimated capital cost *per line*. In other words, if a subscriber has two instruments on his line, one in his outer office and one in his private room, he is to count as two subscribers, although one of his instruments costs only £2 10s. plus a few shillings for wiring and switch.

The explanation put forward in support of counting each instrument as a line is so absurd that it is surprising that any technical journal should print it. It is as follows:—"When an extension instrument is placed in a room in the same building, the instrument which was estimated for is used, so is the lightning guard and the internal wiring. The line in the cable estimated for another instrument is still in the cable and free to be used—so surely that spare line remains an asset. The department have actually incurred the expense of a complete line, although only the instrumental portion of it has been put to immediate use; the remainder, according to the most exact idea of accountancy, must go to credit in the spare line ledger."

As a matter of fact, the installing of an extension instrument on any subscriber's line has no bearing whatever on any other line being spare or not spare. To argue that the addition to an existing subscriber's equipment of an instrument which can be bought round the corner for 50s., and wired up in a few hours, necessitates the entry in a spare line record of some totally distinct line which has nothing to do with the case, is an insult to the readers' intelligence. If, in municipal telephone systems, the supply of instruments were strictly limited to a number equal to the number of lines in the system, this remarkable explanation of the relation between extension instruments and spare lines might hold water. But as telephone instruments are a commodity

purchasable in any quantity, the argument is simply silly. If the editor of the *Electrical Engineer* had carried his own example a little further, he might have seen the absurdity of it. Suppose the line which becomes spare because an instrument is added to some existing subscriber's line, is taken up by a new subscriber. What does the exact accountant do then? Does he count the three instruments as three lines or as two lines? Does some other line automatically become spare to provide an instrument for the line previously made spare by the first subscriber taking the instrument originally estimated for the second line? We hesitate to think of the complications that would ensue if the second subscriber also wanted an extension station! Would still another line have to go into the spare line ledger to set free the instrument, and would there then be four lines? The poor clerk in charge of that spare line ledger at Glasgow must wish he had never been born.

The real focus of our comparison of the actual results of the Glasgow Corporation system, with the estimates on which that system was founded, is that the capital embarked per £ sterling of revenue is much higher than Mr. Bennett's estimates prophesied. Mr. Bennett and his friends now say that the work done is much greater than the work estimated for, and consequently the original estimate cannot "be held to hold." But this defence is a virtual admission of the soundness of the original criticisms of Mr. Bennett's estimates. Mr. Bennett has always drawn for the municipalities a rosy picture of almost the whole of his plant being in use, and earning full revenue at once. The cost was to be always £19 or £20 per working subscriber's line, no matter what the size of the system, or what the rate of growth. Mr. Bennett left out of consideration a number of factors which have an important bearing on the practical conduct of the telephone business, and laughed derisively at all objections urged by practical men. It was pointed out that Mr. Bennett's estimate of the number of working subscribers' lines to be expected from a given amount of plant was far in excess of the actual results in large telephone systems. Mr. Bennett scouted practical experience, and clung to his optimistic estimates.

Now, once more, how do the actual results compare with the estimates. In 1897, Mr. Bennett said that a municipal telephone system for Glasgow would cost, in round figures, £98,000, and bring in £27,550 in gross revenue. In January, 1904, Mr. Bennett has spent £318,000, and has subscribers giving at the most a gross revenue of £50,000. In the estimate the gross revenue was to be 28 per cent. on the capital; in real life it is less than 16 per cent. This is stripping the question of all arguments as to whether an instrument is a line, or whether spares can all be used or not, and putting it in plain terms which can be understood by the plain business man. If the estimate had been any real guide to the results to be achieved by municipal telephony in Glasgow, the present investment of £318,000 would produce a gross income of nearly £90,000 instead of the £50,000 it does produce—a trifling difference of nearly £40,000 a year.

Mr. Bennett's defence is that more work has been done than his original estimates called for, that work has been executed in excess of the immediate requirements, so that the original estimate is gone. At the same time that this view is put forward, the Glasgow Corporation, presumably on Mr. Bennett's advice, seeks to borrow £50,000 more capital for the telephone system, so that new subscribers may be "wired on without delay." From this it seems that in Glasgow telephone circles it is now recognised that work must continue to be executed in excess of the immediate requirements, and that a margin of spare plant must be maintained. This is a feature of telephone work which must be reckoned with in calculating capital cost, and Mr. Bennett's omission to reckon with it adequately in advance is partly responsible for the wide difference between his estimates for the Glasgow telephone system and the actual results. It is idle to say that the work executed is more than had been contemplated. That Mr. Bennett's estimates contemplated so little work for so many subscribers was precisely the point wherein they were most mistaken. If those estimates had really represented the approximate cost of telephoning Glasgow, the present Glasgow system of about 9,000 lines and 2,000 extension instruments would have cost under £200,000, instead of over £300,000.

THE NATIONAL PHYSICAL LABORATORY.

The annual inspection of the National Physical Laboratory at Bushey House by the General Board took place on the 18th inst. The laboratory, since its establishment in 1902, has carried out a considerable amount of test and research work which has been of great value to the engineering, physical, and chemical industries, and is capable of doing a great deal more, but like most scientific institutions, in this country, it suffers from lack of funds.

The receipts for the year 1903 amount to £10,200 4s. 3d., while the expenditure has been £106 10s. 3d. in excess of this amount. There has been an increase in the income for test work, but this has been more than counterbalanced by the additional expenditure, arising mainly from additions to the staff and to the working expenses. The period for which the Government grant of £4,000 was originally made, ends in September, 1904, but the period has been extended to April, 1905, by the Treasury, who have under consideration a new scheme drawn up by the Executive Committee for the future work and organisation of the laboratory. Since the laboratory was started, similar institutions have been installed in France and America. In Paris the new buildings of the Laboratoire d'Essais have cost £27,000, while £20,000 has been spent on equipment, the grant for the first year's income being £5,500. In Washington the buildings of the Standards Bureau are to cost £70,000, the equipment £45,000, and the annual grant is now £19,000. Evidently other countries appreciate better than we do the importance of applying the latest discoveries of science to industry.

One of the most interesting pieces of apparatus in the laboratory was the tide-predicting machine belonging to the Indian Government. This machine, designed by Lord Kelvin, and Mr. Roberts, of the Nautical Almanac Office, has already been used for 20 years for the prediction of the Indian tides, and has now been transferred to the care of the National Physical Laboratory. The machine, which is the property of the Indian Government, underwent thorough repair during the early part of the year. Thirty curves have been run off on the machine, and the work of measuring these to obtain heights and times of high and low water is proceeding. The machine combines a number of simple harmonic motions representing the different elements of the tide, by the ingenious device of a single wire passing over friction pulleys on the reciprocating slides.

An apparatus has been erected for ascertaining the amount and distribution of pressure on plane surfaces exposed to a uniform current of air. The results of these experiments, which have been described in a paper read by Dr. Stanton at the meeting of the Institution of Civil Engineers on December 22nd last, will be of great value to engineers engaged in the design of structures exposed to wind pressure. It has been discovered that the pressure on a large structure can be deduced from experiments on a small model exactly similar in shape, but no general rule can be laid down for calculating the pressures on structures of different shapes. An apparatus on a larger scale is being constructed to ascertain the effect of wind pressure on models of structures of considerable size. A tower 50 ft. high has been erected, and a lever arrangement has been designed by which the surfaces to be compared can be adjusted to various distances from the fulcrum till the pressures balance.

An apparatus has been erected in the main engineering laboratory for determining the constants of steam; the first of these undertaken being the specific heat of superheated steam. The steam is heated up to about 300° C. by a resistance heated by an electric current, the temperature of the steam being taken by thermometers at the points where it enters and leaves the superheater. The present apparatus is capable of giving a maximum flow of 40 lbs. of steam per hour, and a larger apparatus is being constructed.

In the electro-technical department, arrangements are being made for dealing with heavy currents both alternating and direct, as well as high voltages. A 5-KW. motor-alternator, presented by Messrs. Siemens Bros., has been put down and tested. Single-phase, two-phase and three-phase currents can be obtained from this machine at frequencies varying from 20 to 120 alternations per second. A large

number of electric meters of the best standard type have also been added to the equipment.

In the physics department an elaborate series of tests on the mercury standard resistance have been carried out, the results of the observations showing that the international ohm is known within ·001 per cent. Wire standards of resistance standard cells, and a Jones and Ayrton's ampere balance have been constructed and tested.

Considerable additions have been made to the photometer room. Messrs. The Robertson Electric Lamps, Ltd., of Hammersmith, have undertaken to make and present to the laboratory, a set of large bulb secondary standards with voltages ranging from 100 to 250 volts, and candle-powers from 8 to 100. Amongst the apparatus in this room, is a photometer bench (Reichsanstalt pattern) by Messrs. Schmidt and Heensch; a Harcourt 10-C.P. pentane lamp; a Trotter bar photometer; a Crompton potentiometer; a Kelvin electrostatic voltmeter and Ayrton & Mather reflecting galvanometers. An apparatus has been made for automatically regulating the voltage of lamps on life test. Tests have been made on the Harcourt pentane lamp, with the view of determining the variation of its light intensity with barometric pressure, as well as with humidity and carbon dioxide in the air.

For experiments on optical glass the following apparatus has been provided:—A Pulfrich refractometer, for the measurement of refractive indices and of dispersion, with a heating apparatus for determining the refractive indices of liquids at temperatures ranging to about 75° C.; a König-Martens spectro-photometer, for absorption measurements. The department is now prepared to undertake the determination of the optical constants of glass and other substances. Experiments are also in progress relative to the use of mercury lamps for optical purposes, especially in connection with the specification of glass for the information of optical instrument makers.

The observatory department still continues to perform a large amount of useful work; its most extensive business, judging by numbers, is the testing of clinical thermometers, telescopes and watches. The magnetic observatory is to be removed to Eskdale Muir, Dumfries-shire, in order to avoid the disturbances caused by the extension of electrical installations. Daily measurements are made at the observatory of the potential of the air by a water-dropping apparatus. An Elster & Geitel dissipator, to test for free positive and negative ions in the atmosphere has also been set up, but few observations have been made owing to the pressure of other work.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Small Gas Engines v. Electric Motors.

In his reply, the author of the above article, whilst taking exception to some of my figures, neglects some of the main points I desired to draw attention to.

The author objects to my taking 88·8 cb. ft. of gas to run the 14 B.H.P. engine without load, as he considers this excessive. I agree with him, but the figure was obtained from his article which gave an efficiency of 76 per cent. for the engine, and bringing this to indicated horse-power gives the consumption as above.

The other examples the author favours us with, this week, are, to my mind, equally unreliable, taking the case of the engine running on no load, for 27·7 cb. ft. per hour. If this is a tube ignition engine, the Bunsen will burn 8 cb. ft. of this, and I don't think he can run the 9½-B.H.P. engine on the remainder.

Are we to understand that the 1·33d. per B.H.P.-hour is for gas alone in the case of the 33-B.H.P. engine, and includes everything? With regard to my query as to what public authority would supply current to a 10-B.H.P. motor for a quarterly consumption of 680 units at 1·5d. per unit, the author is silent. On referring to the conditions of electric current supply of the Bradford Corporation, I find no motor must be installed for any overload; therefore to equal a 14-B.H.P. gas engine will require a 14-B.H.P. motor, and the minimum consumption of current for this, if supplied at 1½d. per unit, is 175 units per rated or brake H.P. per quarter, so the total consumption would be 175 × 14 = 2,450 units at a cost of £15 16s. 3d., a very different figure from the author's.

Does the writer of the article seriously state that a 6-B.H.P. motor can be delivered and fixed, with starting switch, cut-outs, and wiring for £27? If so, all I can say is—where?

Mr. Wylde gives an interesting comparison which I should like to analyse. The consumption of current for eleven weeks is given as 7,074 units, which equals per week, say, 643 units, this with a motor of 92 per cent. mechanical efficiency should give us 793 B.H.P.-hours.

Then if we neglect the extra work done by the gas engine, "due to the erection of another building" and more shafting, and taking the weekly gas bill as being equal to 15,000 cb. ft., viz., £1 13s. 9d. at 2s. 3d. per 1,000=15,000 cb. ft., and dividing this by the B.H.P.-hours of the motor, we get further interesting figures for an engine "much underloaded which has since improved." $\frac{15000}{793} = 18{\cdot}9$, say 19 cb. ft. per B.H.P.-hour, which I think could not be substantiated, and is too good to be true.

H. Mensforth.

London, *March 15th*, 1904.

The Sterilization of Water by Ozone.

In reply to the inquiry of your correspondent "E. T. W.," in your issue of last week, may I draw his attention to articles on the above subject, published in the Electrical Review, July 29th, 1898, and the *Engineer*, November 20th, 1903. These two articles give practically all the information that is at present available, relating to the production and utilization of "ozone."

John B. C. Kershaw.

Waterloo, Liverpool,
March 19th, 1904.

Municipal Appointments.

No doubt many of your readers will agree that the extract given by your correspondent, "A. J. B.," under the above heading, and taken from Mr. Blake's articles in the *Business World*, is very nice as a poetical effusion, but scarcely applicable in the cases under discussion. To quote "A. J. B.'s" letter, "the possession of these qualities is the best pull a young man can have," &c. The trouble all arises from the fact that no qualities, or rather qualifications, are taken into consideration in the making of municipal appointments, except close acquaintance with, or a similar claim upon, those in authority.

In successive issues of recent date, two of your correspondents, signing themselves "Candidate" and "Ex-Applicant" respectively, gave their experiences regarding the futility of anyone applying for a municipal appointment (however suitable he may be for the vacant position) unless he happens to have "friends at court," thus possessing the most useful quality possible, and one which "A. J. B." forgot to mention in his quotation.

Previous to reading "A. J. B.'s" letter, I had no intention of giving my own opinion on the Farcical Comedy entitled Municipal Appointments, but I think I can instance an even more palpable case of a "put-up job" than those mentioned by the above two correspondents.

Quite recently, a City Council in the West Riding of Yorkshire which, rightly or wrongly, prides itself upon its municipal enterprise, advertised for an assistant electrical engineer.

Over 100 applicants applied for the post, only to find the affair terminate in the usual fiasco. No half-dozen or so applicants were invited to appear before the committee (as would surely be the case if the advertisement were genuine), but, as a matter of fact, the man for the place was already "spotted," being none other than the chief engineer's late assistant at his previous station.

The absurd side of this little bit of trickery presents itself to anyone acquainted with the following facts:—In spite of the Standing Orders of the Council, the Electricity Committee had appointed their official's "own familiar friend," advertised the post as vacant, and employed and

paid the appointed one's salary before obtaining the consent of the Council to seek assistance at all.

This is another example of how the butchers, grocers, cotton-spinners, &c., who comprise our Electricity Committees make their municipal appointments, compelling their fellow-townsmen to pay for the advancement of favourites instead of technical ability. Surely something could be done to stop this dishonest practice of inserting advertisements regarding a presumed vacancy, already filled up, thus wasting not only the ratepayers' money, but time and energy on the part of applicants who are, no doubt, more than sufficiently competent for the post (very often more so than the appointed favourite), but who do not possess the requisite amount of "backing up" influence of those in authority. I could quote other instances of a similar character to the above, but——"'nuff said."

Disgusted.

ROYAL COMMISSION ON LONDON TRAFFIC.

At the sitting on March 17th, evidence was given by Mr. R. W. Perks, M.P., formerly solicitor to the Metropolitan Railway Co., and now chairman of the Metropolitan District Railway. Witness described the many negotiations he, as solicitor for the Metropolitan Railway Co., carried out for extensions and amalgamations, to carry out the policy of Sir Edward Watkin to give communication through London from the North to Continental ports. He put in a table showing the mileage of the District Railway in its different branches, including the last piece constructed from Ealing to South Harrow, which was worked electrically and cost £51,000 per mile. He pointed out that the Inner Circle had failed in its object, inasmuch as the natural flow of traffic was from east to west. His company were trying to reduce their trains on the Inner Circle and to give increased facilities on the suburban lines. Proceeding to deal with the existing statutory and other arrangements which the District Co. had with different companies, witness said they had tried to get the London and North-Western Railway Co. to agree to the running of the District Co.'s electric trains from Earl's Court round to Willesden, but the L. & N.W. Railway Co. did not agree to this. The result would be that at Earl's Court the steam engines would have to be detached, and the North-Western trains hauled round to the Mansion House by electric motors. He felt that the inconvenience would be so manifest that it would not last. Continuing, witness dealt with the policy of the District Co. in extending its railways in the east and west. The Whitechapel and Bow Railway had proved a great advantage, and they had put on an enormous service of workmen's trains The Acton Junction Railway was constructed to connect their lines with the systems of the Midland and the London and North-Western. Explaining the objects of the powers obtained in the Metropolitan District Railway Act, 1897, he said that that Bill was for the construction of a deep-level railway from Earl's Court to the Mansion House. It was proposed to be a two-minute service. Witness dealt with the financial transactions of the District Co. He said that in 1900 that company secured a site in Chelsea for its own purposes, as it had not anticipated being connected in any way with the tube line. The District Co. got into conflict with the Metropolitan Co. on the question of the system to be adopted, and the arbitrator appointed by the Board of Trade had decided in favour of the District Co. The power house had been constructed on a much larger scale than was at first anticipated. It had been financed by a number of American friends who were struck with the possibility of development. The power house was not yet quite completed, but he believed that the machinery was in course of being put in. The whole of the work in connection with the power house had cost 1½ millions, and its output would be 60,000 kw. Current would be supplied to a large number of tube railways, and also to the Whitechapel line. In reply to a further question, he said that the furthest point to which current would be transmitted was some 16 or 17 miles. The District Co. had Parliamentary security for a continuous supply. With regard to the question of interchange between the Great Northern, Piccadilly and Brompton and the District, he said that the carriages of the latter railway would come up to the surface at a point some 300 yards to the west of West Kensington station, for cleaning and repairs. Under the new system, it would be possible to get from Hammersmith to King's Cross in 30 minutes, from Charing Cross to Euston in 10 minutes, from Charing Cross to the Midland in 15 minutes, from Charing Cross to Highgate in 19 minutes, and from Charing Cross to Hampstead Heath in 19 minutes. By the Baker Street and Waterloo Railway it would be possible to get from Charing Cross to the Elephant and Castle in 8 minutes, and from Charing Cross to Baker Street in 10 minutes. Paddington would take 3 minutes longer. The distance from Hammersmith to Bow would be covered in 39 minutes.

On Friday Mr. Perks continued his evidence, and said the cost of the Whitechapel and Bow Railway, which was a shallow railway running under the Mile End Road, worked out at £643,701 per mile. It had been suggested that shallow tramways should be constructed under the Strand, Fleet Street and Ludgate Hill, but in such streets there would be a great deal of compensation to pay to frontagers, many of whom had cellars running under the streets.

By Mr. Gibb: He could not see that the cost of a shallow tramway would be much less. The walls and the roof of the tunnel would be just as costly in the case of a tramway as a railway. The lighter rails would be a little less costly, but more stations would be required for a tramway. He doubted whether the Board of Trade would allow tramways to run in a tunnel in the dark without automatic signalling. Witness dealt at considerable length with the question of fares, and said the District Railway was in favour of a uniform fare for all classes with no favouritism to working-men. They were running a great number of workmen's trains, and it was getting a little embarrassing. They were prepared to have a uniform fare of 2d., and he considered the working-man was well able to afford that, for they could afford to have six or seven glasses of beer a day. He considered that it was most inexpedient that the L.C.C. should become the railway and transit authority for London and the suburbs, for the Council would be competitors with them, and the constitution of the Council was not such as fitted it to be charged with the duty. He did not see how it was possible to give the L.C.C. jurisdiction over the rates, &c., for it would put the Council in the position to ruin any particular railway, with a view to acquiring it themselves.

Continuing, Witness said the Underground Electric Railways Co. was their financing company, but that company had no interest whatever in any of the manufacturing work. They looked for their profits, to the apprecation of the District Co.'s stocks, and their sole object was to get everything at bed rock prices. For instance, the Brush Co. was doing a great deal of work, but no one connected with the Underground Electric Railways Co. had any interest in that company. Everything was put out to tender, and no favouritism was given to anyone. They objected to the talk of the County Council as to the mysteries of their finance. He was in favour of a tribunal of three devoting its whole time to the subject, before which everything affecting the traffic of London should come for consideration and report. Such a tribunal could not oust the jurisdiction of Parliament, but their report would have to go before a Joint Committee of both Houses. The tribunal would have to be appointed by the Government or the Crown. The jurisdiction of such a tribunal should certainly at first be restricted to the London area. With a view to increase the efficiency of London Railways and enable them to provide suburban services, witness submitted the following points for consideration:—

1. A serious attempt should be made by the directors of the Metropolitan and the District Cos. to amalgamate those two undertakings.
2. Either upon the amalgamated undertakings or upon the separate undertakings there should be a uniform rate imposed for all classes, some special provision being made for such passengers who desired for an extra charge to travel in a separate car.
3. Railway companies should have power to run upon main thoroughfares cars propelled by electricity or other power as feeders for their main lines along routes beneath or over which it was inexpedient to construct railways, and that power should be given to the railway companies to subscribe to tramcar undertakings.
4. That the present prohibition upon railway companies acquiring and holding land should be removed so that the railway companies might be encouraged to construct suburban lines by looking, to some extent, for their remuneration to the increment which would take place from the value of the lands by the construction of the railways.
5. That the railway companies should be exempt from local taxation along routes where new competition has been set up by the local authorities running at a public cost competitive tramcar or railway undertakings.

By Earl Cawdor: The estimated cost of the District Deep Level Railway to be electrically worked from Earl's Court to Mansion House was £347,000 per mile; that would be 45 ft. below the existing rail level of the District Railway. If it was a success it was capable of very considerable extension under the District Railway. He would like to see a broad circular road constructed all round London which would couple up the towns, and on which electric tramcars might run.

By Sir G. T. Bartley: They ran 18 trains per-hour on the District Co., but when the line was electrified they would run 38 per hour. The Board of Trade had approved of their signalling arrangements.

Mr. Charles T. Yerkes was the next witness. He had no doubt that some tribunal should be formed. The custom of depending on a Parliamentary Committee to decide properly all questions of a Bill was asking too much of the Committee. He considered Committees were most unfortunate, and he felt a great sympathy for them. Very often they were not familiar with many of the details submitted to them. He knew an engineer, who was a clear-headed man, and who had given him, in his office, very clear details of a scheme, yet he had seen that man completely turned upside down by a clever counsel. Afterwards the engineer had admitted that he had been made to say things he had no intention of saying.

Continuing, Witness said that in his opinion there should be a tribunal of not more than five members, each to be paid a salary, and give his whole time to the work of considering such things as new railways, streets, &c. None of the members should be a lawyer or an engineer, but the tribunal should be able to employ engineering and legal advice. To have such a tribunal to report on a Bill before that Bill went to Parliament would be very advantageous.

The Committee then adjourned.

PARLIAMENTARY.

Torquay Tramways (Dolter Subface Contact).

This Bill came before Mr. Russell Rea's Select Committee of the House of Commons recently.

The Hon. J. D. Fitzgerald, for the promoters, said that it was a Bill which sought power for the construction of electric tramways

in the borough of Torquay. Torquay had both a winter and a summer season, and during both was largely frequented by visitors. The proposed tramways would start from the harbour and one line would go to a place called St. Mary's Church. The other line would come down from St. Mary's Church, through the centre of the town to the harbour. The promoters of the Bill were the Dolter Electric Tramway Co., whose system of traction was new to this country but had been tried with great success abroad. The system was a variation of what was known as the surface contact system, and had the advantage of getting rid of the overhead wires and poles. Counsel handed in diagrams showing the working of the system. Continuing, he said that the Dolter system had been in use for two or three years on the Bois de Boulogne, in Paris, without any accident having occurred. There was no opposition to the present Bill from either the local authority or the frontagers, but petitions had been lodged by the Torquay Gas Co. and one by a gentleman, part of whose land it was proposed to take for a widening. The opposition of the gas company was on the ground of possible electrolytic action on their mains, and their petition asked for a special protecting clause in the Bill. Having dealt with the petitions at some length, counsel proceeded to call evidence.

Mr. J. E. Waller, of Messrs. Kincaid, Waller & Manville, civil engineers, was called and examined on the question of possible damage to the gas pipes by electrolytic action. He was familiar with the history of the conflict with regard to that question. The Board of Trade regulations stipulated that between the extreme ends of a return rail there must not be a greater fall of potential than 7 volts.

Cross-examined by Mr. Claude Baggallay (for the Gas Co.), Witness said that the Dolter system was not before Lord Crosse's Committee. The systems before the Committee were the overhead and the conduit systems. Questioned as to the working of the system, he explained that if the lever did not fall back after the passing of the skate, there was another skate so arranged that it had a direct connection with the rail, and if that stud was alive when the following skate came to it, the current would flow direct to the rail, and so cause a short circuit which would blow the fuse, and so deprive the stud of current. There was no liability of leakage during wet or snowy weather. The leaking from a few studs would not constitute a non-compliance with Board of Trade regulations.

Re-examined by Mr. Vesey Knox: The insertion of a protecting clause on electrolysis had no reference to the system being a surface contact system.

Mr. W. C. C. Hawtayne, consulting engineer to the company, was called. There was, he said, no danger of any continuous leaking. There was only a danger of leaking when the skate was in contact with the stud.

On March 14th the Committee having heard further evidence, found the preamble of the Bill proved, and ordered the insertion of the special clause protecting the Gas Co.

The Committee has reported to the House to the following effect:—

That the time limited for the construction of the tramways proposed to be authorised by the Bill (namely, six years) is in excess of the period allowed by the Standing Orders, but the Committee are of opinion that such period should be allowed in view of the restrictions imposed upon the company by the agreement scheduled to the Bill, and that Standing Order No. 158A (Section D) need not be enforced.

Tyneside Tramways and Tramroads.

The House of Lords Committee, of which the Earl of Barnet is chairman, had this Bill before them on March 17th.

The case for the promoters was opened by Mr. Balfour Browne, K.C. The Bill, he said, was to empower the company to construct a short length of tramway to Gosport, where existing lines, owned by the company, would be connected. That was if the Bill was not opposed. The most important part of the Bill had regard to the question of running powers over the municipal tramway system of Newcastle-on-Tyne. At present the Tyneside Co.'s lines terminated at the boundary of Newcastle on the South Shields side. The proposal by the company was that their cars should be empowered to run over the municipal lines and that the Corporation's cars should run on the company's system. That was opposed by the Corporation of Newcastle, but he failed to see for what reason. It was not the intention of the company to take any of the fares collected in Newcastle, except enough to pay for working expenses, and the company would afford similar facilities to the Corporation. On the opposite side of the Tyneside Co.'s system, the Tynemouth and District Co.'s system terminated. Although this latter had a gauge of 3 ft. 6 in., arrangements were being come to to lay a third rail outside the existing rail, so as to make a 4 ft. 8½ in. gauge as well, so that the full gauge cars of his company could run on the Tynemouth and District Co.'s system. If an arrangement could be made in Newcastle there would, therefore, be a continuous route available from North Shields to Newcastle.

Mr. McLellan, manager of the Tyneside Co., was called, and said that there would be no difficulty in working on the proposed method.

On 18th inst., Witness was cross-examined by Mr. Lloyd, K.C., for the Newcastle Corporation, on the question of precedents for compulsory running powers. From Wallsend eastward the company's line was a single one with passing places, which was not so convenient, he admitted, as a double line. The cars of his company kept time, and fitted in with the Newcastle cars as far as was possible. It was true that the North-Eastern Railway was electrifying its line in the district. That would undoubtedly be an advantage to the district, but it would not fulfil all the requirements. Questioned as to the effect of the changing in the centre of Newcastle, witness said that he did not consider that it would in any way dislocate the traffic on the Corporation tramways. It was true that there were a number of places in the city where changes of cars had to be made, but it was impossible to have any system running to a number of places on which passengers would not have to change cars. The electrification of the North-Eastern Railway was an additional reason why the tramway company should improve its service.

A large number of local witnesses gave evidence in support of the Bill.

On 21st inst., the case for the promoters was continued. Mr. F. Davison, surveyor to the Willington Quay Urban District Council, was called, and supported the Bill on behalf of his Council. The company had, said witness, always given every satisfaction. Through running was absolutely necessary on the lines in question.

The case for the Newcastle Corporation was opened by the calling of Mr. Cail, the chairman of the Tramway Committee, who said the question of the exchange of running powers was mooted so long ago as 1902. If passed, he thought the Bill would result in serious injury to the Corporation; it would mean a needlessly large number of cars running through the streets of the city. He did not think it would be of any benefit to people not to have to change cars. Then, again, there were difficulties in the way of checking receipts.

Mr. John Young, the tramway manager to the Corporation of Glasgow, considered it most unwise to allow small outside companies to have running powers over Corporation systems inside a large city. There must be a break somewhere, and the best place for it was outside the city and not inside.

Counsel suggested calling evidence to show how the arrangement between the Manchester and Salford Tramways worked, but the Chairman of the Committee considered that quite unnecessary. They did not desire further evidence on the point. After a short consultation, the Committee found the preamble proved, and the Bill was ordered for third reading.

Newcastle-on-Tyne Tramways.

The Newcastle Corporation Bill came before a Select Committee of the House of Lords, presided over by Lord Erne, on Tuesday. The promoters were represented by Mr. G. W. Freeman, K.C., Mr. H. Lloyd, K.C., Mr. H. Hamilton and Mr. G. J. Talbot. There were a number of petitions against the Bills, among the petitioners being the Newcastle-upon-Tyne Electric Supply Co, Counsel Mr. Balfour Browne, K.C., the Hon. J. E. Fitzgerald, Mr. E. Shortt and Mr. Linden Macassay, and the North-Eastern Railway Co., Counsel Mr. E. Moon, K C, and Mr. Acworth.

In opening the case for the promoters, Mr. H. Lloyd said that the Bill was an omnibus Bill, and dealt with a great many matters. He proposed to deal first with the tramway proposal and the Scotswood Bridge proposal, which, to some extent, were connected. Tramways Nos. 1, 2, 3, and 3A proposed to connect the districts of Scotswood and Blayden with Newcastle. The local authority was in favour of the scheme, but these lines were objected to by the Durham County Council and the North-Eastern Railway Co. The County Council contended that the roadway was too narrow in parts to accommodate a tramway. As a matter of fact, only a single line was intended. He submitted, further, that the Council were not the roadway authority, and therefore had no *locus*. The objection of the Railway Co. had reference to a level crossing. Continuing, counsel said that No. 8 tramway ran north into the district of Walker, and tramways 10 and 11 connected Long Benton with Newcastle.

Mr. Balfour Browne, K.C., for the Newcastle-on-Tyne Electric Supply Co., then addressed the Committee. He said that the objection of his clients was based on the ground that the Corporation were proposing to construct tramways and work them electrically with current supplied by the Corporation, in an area where the Supply Co. were authorised to supply energy. Had a company constructed the lines, the energy would, in all probability, have been taken from the Supply Co., and not from the Corporation.

Mr. Moon, K.C., having argued the *locus* of the North-Eastern Railway Co., which was allowed,

Mr. W. Cail, the chairman of the Newcastle-on-Tyne Corporation Tramways Committee, was called. He stated that the lines were to be made at the request of the various districts through which they passed. In cross-examination, he said that he considered that it would be more advantageous for the Corporation to supply its own current, even though it cost a little more, than to go to the Supply Co. for power, as they would then ensure a continuous supply. The Committee adjourned.

St. Marylebone Electric Lighting.

The Bill promoted by the Metropolitan Borough of Marylebone for powers in connection with their electric lighting undertaking was considered by Sir A. H. Brown's Select Committee of the House of Commons on Monday. The promoters were represented by Mr. J. D. Fitzgerald, K.C., Mr. Lloyd, Mr. Vesey Knox, and Mr. A. B. Caine. Petitions against the Bill were lodged by the London County Council, Counsel Mr. Freeman, K.C.; the Metropolitan Electric Supply Co., Counsel Mr. Balfour Browne, K.C.; and the Gas Light and Coke Co., Counsel, Mr. Balfour Browne, K.C. and Mr. Erskine Pollock, K C.

The case for the promoters was opened by Mr. J. D. Fitzgerald, who went into the history of electric lighting in Marylebone. The present Bill had regard to the agreement between the Marylebone Borough Council and the Metropolitan Electric Supply Co., by which the Council agreed to purchase that part of the company's undertaking which was within the district, except an office and one or two large trunk mains, which conveyed current from the power house at Willesden to districts the other side of the Borough of St. Marylebone. It will be remembered that the price which the arbitrator decided should be paid by the Council to the company was £1,212,000, and Mr. Fitzgerald explained that to that sum had been added the capital expenditure of the company since December 31st, 1901, the date when the valuation was made, the expenses of the arbitration, which lasted over 30 days, and various smaller expenses which, taken together, brought the total to £1,365,000. It was partly for the purpose of raising the money to pay the company that the present Bill had been promoted. The Bill also sought powers to borrow a sum of £460,000 for the purchase of land for the erection of a generating station. The site of the proposed station was an admirable one, situated within the borough. Part of the site was already owned by the Council, and used as a store yard. It was very conveniently situated, being on the bank of the Regent's Canal, and within a short distance of the Great Central Railway goods depôt. The Council asked for a period of 42 years within which to repay the loans. Counsel then proceeded to deal with the petitions.

The Chairman asked if the Borough Council could borrow without the sanction of the London County Council, or would they have to borrow through that body.

Mr. Freeman, K.C. (for the L.C.C.), explained that the London County Council was the only authority in London able to borrow for all purposes. In their estimates every year they included certain sums on application from the borough councils. In other matters borough councils could borrow without the sanction of the L.C.C., as they had an appeal to the Local Government Board. A question had arisen as to whether the charge would be on the local rates or the L.C.C. rates, and a report on this by the Finance Committee of the L.C.C. would be presented at the meeting of that body on the morrow. He asked the chairman if it would be convenient to adjourn the matter over Tuesday, so that the Council's decision might be known. It was very important that the security should not be weakened.

The Chairman said that the Committee would adjourn over Tuesday at the conclusion of that day's proceedings.

Mr. E. Debenham (Debenham & Freebody), the chairman of the Electric Lighting Committee of the Council, was then called, and, having given evidence of a historical character, the Committee adjourned.

Harrow Road and Paddington Tramways.

This Bill was before Mr. Tatton Egerton's Select Committee of the House of Commons on Friday last week.

The promoters were represented by Mr. Baggallay, K.C., who, in opening the case, said that last year the company secured powers for the transfer of their undertaking to the Metropolitan Electric Tramways, Ltd., and also for the doubling of their single track. The proposal of the present Bill was to execute certain street widenings in order to carry out the latter part of their Bill of 1903. The only opposition to the scheme came from the Gas Light and Coke Co., and the Metropolitan Electric Supply Co. The former had been amicably settled by the acceptance of a clause which provided that any extra expense thrown upon the company by reason of increased difficulties of access to their mains through the existence of the double line of rail should be borne by the tramway company, the work to be carried out, however, by the engineers to the gas company. The opposition of the Metropolitan Electric Supply Co. was of a similar nature. The company had been offered the same clause, but had refused it. The facts of the case were that when the double line was constructed, one of the supply company's big trunk mains supplying London, would be underneath the track, and the request was that it should be moved further from the track by the tramway company. Counsel doubted whether the provisions of the Tramway Act with respect to such matters applied to an electric supply company, but in spite of that the company had been offered the clause.

Mr. Stephen Sellon, engineer to the scheme, was then called. The total length of track was, he said, about 2½ miles. With regard to the main, he did not consider that there would be any necessity for its removal.

The Chairman interposed at this point, and observed that the Electric Supply Co. should have raised their objection when the doubling of the track was authorised last year.

Mr. Balfour Browne, K.C., for the Supply Co., said that the company could not have done that, as no street widenings were proposed at the time.

Mr. J. S. Highfield, chief engineer to the Supply Co., was called, and said that the main was a huge one, and would occasion serious inconvenience in case of breakdown if it were allowed to remain under the track. All they asked was that it should be removed to a more accessible spot.

Counsel on both sides having further addressed the Committee, the Chairman said that the Committee were fully agreed that the clause, as offered by the Tramway Co., should be allowed to stand. The preamble of the Bill was declared to have been found proved.

Charing Cross, Euston and Hampstead Railway.—Mr. Russell Rea's Select Committee of the House of Commons had this Bill under consideration last week. The Bill provided for the raising of £100,000 of further capital, but Sir Ralph Littler, K.C., in opening the case for the company, said that as the company had already a margin of some £200,000 under their existing Act the financial part of the scheme would not be proceeded with. The only matter which remained was the question of the compulsory purchase of a part of the cellars of Messrs. Meux, in the Tottenham Court Road. On Monday, the clauses relating to the raising of additional capital having been withdrawn, the question of compulsory purchase of part of Messrs. Meux's premises was further considered. The preamble was declared proved, certain conditions with regard to the premises in question being imposed. Clauses were then adjusted, and the Bill was ordered for third reading.

Watford and District Tramways.—The Select Committee of the House of Commons, of which Mr. Tatton Egerton is chairman, had this Bill before it on Friday last week. Mr. Lewis Coward, K.C., for the promoters, said that the Bill was for an extension of time for the construction of the tramways authorised by the Watford and District Tramways Act, 1901. The Hertfordshire County Council and the Watford Urban District Council opposed on the ground that the financial position of the company was not sufficiently strong to guarantee that the works would be carried out. Evidnce for the promoters was called, but the Committee, after listening to lengthy examinations and cross-examinations, came to the conclusion that the preamble had not been proved.

LEGAL.

Llanelly Tramway Co. v. Llanelly and District Electric Lighting and Traction Co., Ltd., and the British Insulated and Helsby Cables, Ltd.

This case came before Mr. Justice Joyce in the Chancery Division on Wednesday and Thursday last week. It was an action by the plaintiffs asking for specific performance of an agreement dated October 22nd, 1900, for the sale by the plaintiffs to the defendants of a piece of ground situate in Robinson Street, Llanelly, together with a building erected thereon. Plaintiffs also asked for the specific performance of an agreement by the defendants to purchase the undertaking authorised by the Llanelly Tramways Order of 1880, certain tramcars, and the benefit of an agreement with the Great Western Railway Co. The plaintiffs claimed payment by the British Insulated, &c., Co. of £5,000 with interest, and asked for damages for non-completion of the agreement.

Mr. Hughes, K.C., and Mr. R. J. Parker appeared for the plaintiffs; Mr. Adams for the first defendants; and Mr. Younger, K.C., and Mr. Vernon for the British Insulated, &c., Co.

Mr. Hughes, in opening the case, said the plaintiff company was incorporated in the year 1881 for the purpose of working a series of tramways in Llanelly. One of the provisions in their memorandum of association was to sell the whole or any of its property, so that there could be no doubt that there was power to sell. The plaintiff company took over the undertaking which had originally come into existence under the Llanelly Tramways Provisional Order of 1880. That order contained in a modified form the provisions of the Tramways Act of 1870, under which the local authority had a right to take the tramways under certain conditions. In the year 1899 the British Insulated & Helsby Cables, which had been called the British Insulated Wire Co., came on the scene. Its business was the construction of electric cables and electric works generally. It proposed to take over the Tramway Co.'s undertaking with a view to constructing electric tramways and also constructing electric light works and working the two in conjunction. Negotiations took took place between the plaintiff company, the Llanelly Urban District Council, and the British Insulated Wire Co. The Council obtained a provisional order under the Electric Lighting Act, so that what the Wire Co. proposed to do was to take over the provisional order under the Electric Lighting Act. They also proposed to take over the tramways undertaking. Negotiations arrived at the point at which the Wire Co. agreed to buy the tramway undertaking. When it came to drawing up a formal contract, the Wire Co. said that as a matter for their convenience, they proposed to form a subidiary company to be called the Llanelly District Electric Light and Traction Co., the reason given being that it was more likely to attract local interest. The Wire Co. proposed that the purchase should be carried out in the name of that company, and accordingly the provisional agreement was entered into between the plaintiff company and the Traction Co., the original agreement having been made by correspondence between the plaintiff company and the Wire Co. No difficulty arose for some time. The British Insulated Co. had, however, changed its mind, and thought it would prefer not to carry out its bargain. They said that they had not entered into any bargain with the plaintiff company, but the bargain was with the Llanelly and District Electric Lighting and Traction Co., and with them only. That was what was said in this action. The Traction Co. had the same directors as the Wire Co., and was entirely managed by the Wire Co., and there could be no question as to what it really was. It had seven shareholders, with one fully paid-up share each. With regard to the Traction Co., he could not see that they had got any defence.

Mr. Adams said the defence of that company was a purely technical defence.

Mr. Hughes said that the question in the action was whether the Wire Co. were not also liable. His Lordship would see from the

letters that the Wire Co. were continually saying, "We are responsible for the Traction Co.," and "We are guaranteeing the performance of the obligations of the Traction Co."

His Lordship asked if the plaintiffs claimed specific performance against the Wire Co.

Mr. Hughes said they did. Plaintiffs also claimed damages against the Wire Co.

His Lordship asked in what respect the plaintiffs claimed the damages?

Mr. Hughes said that the plaintiffs had had to keep this undertaking going for four years up to the date of the writ, and afterwards they were saying that they were going to carry out the bargain. His case against the Wire Co. was that there was a contract by them, that was to say, that they had by representations which were not true in fact induced the plaintiffs to enter into the contract with the Traction Co.

Mr. Hughes said the contract of October 22nd, 1900, was subject to the approval of the Board of Trade.

His Lordship: If the Board of Trade did not approve, would not you be in a better position than you are now?

Mr. Hughes: Yes, in that case the original contract with the Wire Co. would be there. For the purpose of getting the judgment against the Traction Co., it is immaterial for me to prove the question whether the Board of Trade's approval would be given.

His Lordship: What do you care about the Traction Co.?

Mr. Hughes: I want judgment against the Traction Co., because we think rightly, or wrongly, by that means we may get our rights against the Wire Co.

His Lordship: If you get a perfect judgment against the Traction Co. which is good and effectual, what do you care about the other company?

Mr. Hughes: If it is carried out I am content.

His Lordship: You have been a little too trusting in executing the agreement.

Mr. Hughes said that the plaintiffs thought that the directors' word was as good as their bond. But it was not. The form which the agreement took was that, unless the approval of the Board of Trade was obtained, there was no contract at all.

His Lordship: It has not been obtained.

Mr. Younger: It has been alleged by the plaintiffs that it has been obtained.

Mr. Hughes suggested that the consent could be perfectly well obtained by the Wire Co.

His Lordship: If the consent of the Board of Trade to the carrying out of the first contract be necessary, unless you can get it you cannot carry out that agreement, for you cannot convey. But you may be entitled to a decree for specific performance, and if the consent cannot be obtained, you may have to pay all the costs.

Mr. Hughes contended that if the consent was not obtained, owing to the fault of the purchasers, although there might be a difficulty about specific performance, there would be no difficulty about damages for breach of contract. The position taken up by the Board of Trade was that they could approve of the transfer, but they retained to themselves the power, if circumstances altered, of withdrawing that approval. If the Traction Co. would carry out the bargain, plaintiffs did not want the Wire Co. to do so. There was no doubt that the Board of Trade acted on the view that the Wire Co. was taking the responsibility. He claimed that the plaintiffs were entitled to judgment against the Traction Co. for specific performance of the agreement of October 22nd, 1900. If that could not be carried out, by reason of the approval of the Board of Trade not being obtained, then he asked for specific performance of the agreement contained in the letters between the Wire Co. and the plaintiffs.

Mr. Younger protested against any such claim as that now set up against the Wire Co. There was nothing whatever in the original statement of claim, or in the amended claim, to suggest it as a ground of action.

Mr. Hughes replied that in paragraph four of the amended claim the agreement with the Wire Co. was relied on.

His Lordship: You want the sale by you of the tramway, carried out, and to receive the £5,000. That is the object of the action. You wish to make the Wire Co. liable, and to prevent them wriggling out of obligations which morally, if not legally, they entered into.

Mr. Hughes observed that the two defendant companies were practically one, and plaintiffs wanted the contract carried out by one company or the other, either by the Wire Co. directly or by the Traction Co., with the assistance of the Wire Co.

In the result his Lordship allowed the case to stand over until Friday morning to enable the plaintiffs to amend their pleadings.

On Friday Mr. Hughes stated that, since the previous day, the pleadings had been put in form. There was little substantial alteration in the allegations.

The hearing was continued on Saturday, and there was a good deal of evidence and argument. His Lordship asked for the minute book of the plaintiff company to be placed at his disposal for a day or two. Ultimately his Lordship intimated that he would consider his judgment.

Mr. Hughes intimated that the minute book of the plaintiff company would be obtained for his Lordship.

South American Electric Co. *v.* Hyland.

This case came before Mr. Justice Channell in the King's Bench Division on Thursday.

Mr. Gore Browne, K.C., in opening the case for the plaintiffs, said the action was brought upon an indemnity given by the defendant to the plaintiff company against the costs of a certain action. The plaintiff company was one of those companies intimately connected with Mr. Chas. Bright and his dealings in South America. The point in review was mainly a pure point of law on documents. One of the transactions involved in Mr. Bright's affairs was that a number of shares were held by Chas. Bright & Co., Ltd., in the plaintiff company, so that Chas. Bright & Co., Ltd., were shareholders interested in the success of the plaintiff company. The plaintiff company held a number of shares in another corporation, and there was a claim set up against the plaintiff company that it was not entitled to those shares. The plaintiff company was not minded to defend that action. Certain terms of compromise were proposed, and the plaintiff company preferred to accept them rather than fight, but the liquidator of Chas. Bright & Co., Ltd., the present defendant, thought the action should be defended, and accordingly incited the company to defend the action, and gave the indemnity, the subject matter of the present dispute. The action came on for trial, and the plaintiff company were unsuccessful, and were ordered to pay the taxed costs of the plaintiffs in that action. These costs came to about £440. The question his Lordship had to determine was how the indemnity given by the defendant to the plaintiff company should be interpreted, and whether Mr. Hyland, in parting with the assets of Chas. Bright & Co., Ltd., in a manner which the plaintiffs said was perfectly unjustifiable, had not made himself personally responsible, even though he was not personally liable to the plaintiffs on the indemnity.

In the result, his Lordship, in giving judgment, said he was of opinion that the indemnity operated as a personal contract, and defendant must pay. Judgment for plaintiffs for £200 odd, £250 having already been paid them, with costs.

Hunt *v.* The National Electric Traction Co, Ltd.

In the King's Bench Division of the High Court of Justice on Monday, before Mr. Justice Ridley and a common jury, this case came on for hearing.

Mr. Cannot, who appeared for the plaintiff, Mr. Octavius Hunt, said the latter was a subscriber for shares in the defendant company, and he brought the action to obtain the return of £52 10s. as subscriptions, which he said had been obtained from him by misrepresentation in a prospectus of the company, dated July, 1902. The statements which he relied upon, and by which he said he had been misled, were that the defendant company had already built a city terminus electrically equipped with lifts, &c., close to the Monument, that it had already constructed approach lines, fully equipped for running, and that it had constructed and equipped a tunnel under the Thames. All these statements, he said, were untrue, and he asked for the return of his money.

There being no appearance for the defendants, his Lordship, after formal evidence as to the publication of the prospectus had been called, told the jury that there was a clear case of misrepresentation.

The jury found for the plaintiff for the amount claimed, with costs, and for the recession of the contract to purchase the shares.

Ferranti, Ltd.

The petition of Estler Bros. for the winding up of this company was again in the list for hearing before Mr. Justice Byrne on Tuesday last.

Mr. Buckmaster, K.C., said this was a petition on which his Lordship made an order on February 12th, appointing a Mr. Henderson provisional liquidator and limiting the duties he was to discharge under that appointment. The petition was one by a creditor against the company. There was no answer to the petition except that the debenture-holders said the undertaking was very large and a difficult one to manage, that they had been managing it for some time, and that a compulsory order might prejudicially affect the name of the business. His Lordship stated in Court that there was always an apprehension that might be so, and that that might be avoided by appointing Mr. Henderson provisional liquidator, and letting the matter stand over to see how that would work. The matter appeared to have worked to the reasonable satisfaction of the parties concerned, and, if his Lordship would allow it, they were willing it should be continued for another three months on exactly the same terms. Counsel said the view the provisional liquidator took was that it would be for the interest of all parties that a winding-up order should not now be made.

All parties concurring, Mr. Justice Byrne directed the petition to stand over until the last petition day in June on the same terms.

Robertson Fire Brigade. — To-morrow (Saturday) night the employés of the Robertson Electric Lamps, Ltd., are holding a concert in the Works' Hall, Brook Green, Hammersmith, at 7.30 p.m. The prizes won by the works' fire brigade in the recent London competition will be distributed in the course of the evening; also the cup for the championship of London, won by the works' fire brigade, will be presented to the winning team.

PRACTICAL EXAMPLES WITH THE CALCULATOR BOARD.

By EDWARD RAYMOND-BARKER.

Series II.—Notes for Submarine Cable Staffs, and others.*

The calculator board (C.B.) not only, in many cases, facilitates simple geometrical treatment of electrical tests, but invariably adds greatly to the interest of the work, and increases the operator's powers of realisation as to the *rationale* of various methods.

Of this fact, the average telegraph cable official—experienced and intelligent, but with little time for anything but the absolutely essential in mathematics—will become convinced, after perusal of the following representative examples, to which many others might be added.

The diagrams in the following series are given by way of illustration, but, with the calculator board, they are not necessary in practice. The board enables angles and lines to be quickly measured off, mere light pencil marks on the celluloid working surface being all that are necessary, and these only at limits, or at points of intersection of lines.

The first two examples here given prove the aid afforded by the C.B. in angle work.

With the quadrant, *omnibus* scales G_4 and g_3 are used.

On G_4, radius of 100 mm. being taken as unity, viz., 1, tangents and sines of any angle measured off on the quadrant may, to two figures, be read off on scale G_4 as shown in fig. 30, in which :—

$$\text{tan. } a = \text{tan. } 42° \cdot\cdot 45' = 0\cdot92$$
$$\text{,, } \beta = \text{ ,, } 24° \cdot\cdot 45' = 0\cdot46$$
$$\text{sin. } a = \text{sin. } 42° \cdot\cdot 45' = 0\cdot68$$
$$\text{,, } \beta = \text{ ,, } 24° \cdot\cdot 45' = 0\cdot42.$$

The vertical and horizontal cursors of the board used in conjunction with the quadrant radial arm, and scale, render very easy the graphic illustration of various trigonometrical values too numerous for mention here.

Internal Resistance and E.M.F. of Batteries. Foster's Graphic Methods.

Example 18.—Fig. 30 shows application of C.B. to Foster's test for internal resistance and E.M.F. of a battery, when

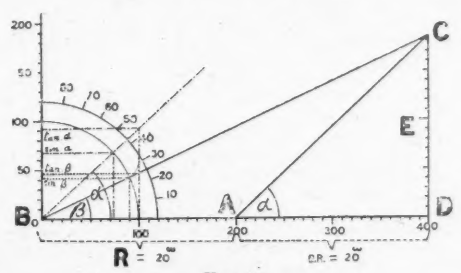


Fig. 30.

a tangent galvanometer is used. Battery gives, on a tangent galvanometer, a deflection of $42\cdot75° = 42° \cdot\cdot 45' = a$.

From point A (on board) $a = 42° \cdot\cdot 45'$ is measured on quadrant.

Tan. $42° \cdot\cdot 45' = 0\cdot92 \div 2 = 0\cdot46 =$ tan. $24° \cdot\cdot 45'$. To reduce a of $42° \cdot\cdot 45'$ to $24° \cdot\cdot 45'$ resistance R of 20^ω is added to circuit.

From B, using scale g_3, 20^ω is measured to A to scale of 10 mm. $= 1^\omega$.

From B, $\beta = 24° \cdot\cdot 45'$ is measured on quadrant. From where B C intersects A C, perpendicular C D is brought to line of resistance.

A D $= b\,r$ required, $= 20$ ohms, but from this 1^ω has to be deducted for resistance of galvanometer, so battery resistance $= 19^\omega$.

The above is a particularly simple case, as the halving of tan a by the addition of 20^ω shows resistance in circuit to have been doubled.

The graphic method is equally correct, by whatever amount a may be reduced to β. Halving the tangent has been adopted here to show at a glance how, when this is so, A D = B A.

Example 19.—Fig. 31 shows Foster's graphic method similar to the foregoing, but with a sine galvanometer. Addition of R to battery and galvanometer reduces a to β.

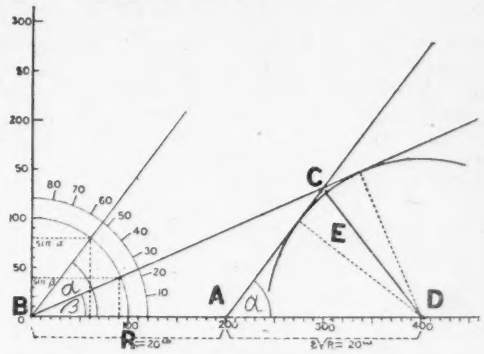


Fig. 31.

That point on the line of resistance from which a circle can be described, touching A C and B C, gives the limit of A D which, after deduction of galvanometer, gives measure of $b\,r$: here $20 - 1 = 19^\omega$.

In fig. 30 C D, and in fig. 31, radius C D give E.M.F. in terms of a standard cell (of a constant type). For instance, if, in fig. 30, a P.O. standard Daniell with sufficient inserted R to make up a total of B A + A D ohms, gave a deflection productive of a perpendicular just half of the measured value C D, it is clear that the E.M.F. of battery under test = 2 Daniell cells, say, 2·158 volts.

Example 18 is an excellent test for the Kelvin tray gravity cells, and is quickly made with the tangent galvanometer generally sent out to cable stations for that purpose.

An ideal battery resistance test is one in which no falling-off of E.M.F. is possible during the test, this being of especial importance with the Leclanché type of cell now so generally used, for which, indeed, the two foregoing tests would be useless.

The best test for this purpose is one made with a condenser and by fall of potential. The first example of this method was originated by Mr. H. R. Kempe.

Fig. 32 shows an application of the C.B. not only to the Kempe test, but also to the modifications of the same respectively by Dr. A. Muirhead and Mr. J. Munro.

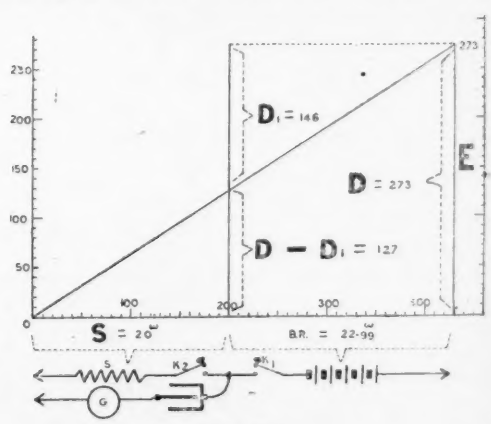


Fig. 32.

Fig. 32 not only illustrates these tests, but shows how the C.B. can measure battery resistance without calculation.

In the present instance, it will suffice to take one example, viz., a Muirhead test, this being very generally employed.

Example 20.—Fig. 32. Internal resistance of 20 "medical" cells Leclanché, measured by C.B.

Let deflection throws be in terms of mm. on *omnibus* scale G_4.

Let resistance be in terms of 10 mm. = 1 ohm on *omnibus* scale g_3.

Key K_1 down gives throw D = 273 divisions.

K_1 kept down, K_2 down to momentarily apply S of 20^ω

* The examples and figures are numbered consecutively from Series I., which was concluded on p. 838, Vol. 53.

lowers P.D. at condenser by the back throw of $D_1 = 146$ divisions, the remaining P.D. at the condenser being, therefore, $= D - D_1 = 273 - 146 = 127$. Fig. 32 shows the *rationale* of all this at a glance.

On C.B., $S = 200$ mm. $= 20^{\omega}$, beyond which is raised perpendicular $D - D_1$ mm. $= 127$ divisions.

From origin of S hypotenuse is drawn, touching summit of $D - D_1$, to point 273 mm. $(=D)$ vertical distance from horizontal line of resistance.

A perpendicular let fall from this point will touch line of resistance at a distance from $D - D_1$, which gives br here seen to be close on $23\frac{\omega}{\omega}$, or $1{\cdot}15^{\omega}$ per cell.

This measuring takes much less time than does its description, and no diagram is necessary: only a few pencil marks on the C.B.

Checking by the longer method of calculation, we get :—

$$D : br + S :: D - D_1 : S,$$
$$DS = (br + S)(D - D_1),$$
$$DS = D\,br + DS - D_1\,br - D_1 S,$$
$$D\,br - D_1\,br = DS - DS + D_1 S,$$
$$br\,(D - D_1) = D_1 S,$$
$$br = \frac{D_1}{D - D_1} S,$$
$$br = \frac{146}{273 - 146} \times 20 = 22{\cdot}99^{\omega} = 1{\cdot}15^{\omega} \text{ per cell.}$$

On the C.B. perpendicular E, viz., 273, gives measure of E.M.F.

For instance, the throw from the same condenser charged from a Clarke standard cell of 1·454 v. gave 13·5 divs. or mm. which $= 9{\cdot}2$ mm. per volt.

This, with compasses, or otherwise, can be measured out on the C.B., or

$$\frac{273}{9{\cdot}2} = 29{\cdot}68 \text{ v.} = 1{\cdot}484 \text{ v. per cell.}$$

Example 21.—Fig. 33 and fig. 34. *Siemens's equal potential method for localising partial earth.*

The object of the present example is to show that the C.B. enables the station using it to—without calculation—

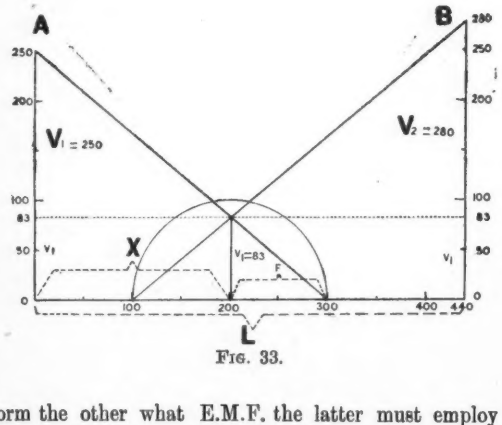


Fig. 33.

inform the other what E.M.F. the latter must employ in order to equalise P.D. at fault, whether A or B applies the battery.

In fig. 33 fault is near the centre of the cable.

In fig. 34 fault is near to one end.

Total CR of cable $=$ L $= 4{,}400^{\omega}$.
Distance of fault from A $= x$ ohms.
Resistance, to earth, of fault $=$ F ohms.

On *omnibus* scale g_3 1 mm. $= 10^{\omega}$.

" " " G_4 P.D.'s are marked off in any convenient units.

Here, when A and B—alternately applying battery to cable—so adjust their respective P.D.'s, V_1 and V_2, that the fault P.D., v_1, remains constant, whether noted by A or by B, the proportion exists :—

$$V_1 - v_1 : V_2 - v_1 :: x : L - x$$
$$x = L \frac{V_1 - v_1}{(V_2 - v_1) + (V_1 - v_1)}.$$

Using C.B. instead of calculation, A would proceed as follows, in the case of fig. 33.

A applies P.D. of, say, 250, which is marked off on scale, $G_4 = V_1$.

At one and the same time, A notes deflection on a low resistance galvanometer between battery and cable, which, when corrected for E.C., gives deflection data for $x + F$; and A also notes, by charge and discharge of a condenser

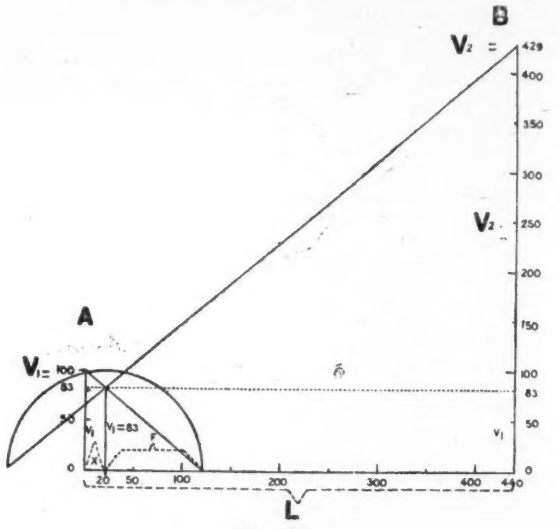


Fig. 34.

through a second galvanometer, P.D. 250 $= V_1$ as already mentioned. By reproduced deflection A finds that $x + F = 3{,}000^{\omega}$. Meantime B, by charge and discharge of a condenser, notes v_1 which is reported to A as 83.

(To be continued.)

INDICATOR DIAGRAMS FROM STEAM TURBINES.

By W. H. BOOTH.

It is so often stated that the steam turbine cannot be indicated that there is a tendency to accept such a statement as true. It is by no means true, but has been made by those whose ideas of indication are drawn from the instrument employed by the reciprocating engine. The steam turbine can be "indicated" with a very considerable degree of precision, and though the writer is not prepared to suggest at the moment an autographic recorder of the "indication," there is very little doubt that such a record could be contrived. An indicator diagram, as usually obtained from the reciprocating steam engine, is a record of the steam pressure at every point of the piston stroke. It is employed as a means of finding the power exerted on the piston. It does not directly tell us the power exerted by the working steam. The power exerted in a steam engine is made up of two parts. First, during the admission of the steam into the cylinder, the heat of the fire under the boiler is directly converted into work, a certain portion of steam being pushed into the cylinder by the direct action of fire causing evaporation in the boiler. If the steam pipes are small, the full boiler pressure may not be carried through to the cylinder, and during the steam admission period the steam which is pushed out of the boiler by the direct furnace heat may act partially by expansion, and do some work during admission. Admitting a level admission line, however, the initial steam does no work by expansion. When the admission valve closes, the enclosed steam expands behind the piston, and does work. In the diagram, fig. 1, the two portions of work are shown by the areas A and B. A is the work done directly by the furnace, and B represents that done by the expanding steam. The line C D is the line of absolute vacuum. The gross work done is represented by the area D C E F. On the opposite side of the piston, however, there is work done by the atmosphere, or by the steam in the exhaust pipes and condenser, and this is shown by the diagram fig. 2, the work done being represented by the area D C G H. The actual indicator diagram as secured from an indicator, does not show the two diagrams which represent one stroke upon the same card, but shows the condition of things on one face of the piston only during two strokes. The actual so-called indicated power of an engine is the difference between the gross forward pressure of all the cards for fig. 1, and the gross backward work of all the cards of fig. 2. The best of two engines may be made to appear the worst if care be not taken to keep to a minimum all the fig. 2 cards.

Such cards as this cannot be got from the steam turbine, but, nevertheless, the pressure in the turbine can be got at any part of

the length, and from this something can be learned of the behaviour of steam in the turbine, and particularly of the effects of superheated steam. Where saturated steam is employed in the turbine, its temperature at any point can be ascertained by means of a mercury pocket of thin brass let into the body of the outer casing. A series of these pockets fitted along the length of the turbine, and fitted with thermometers, will give a series of temperature readings at such points which can be plotted as a curve of pressures by aid of a steam table, or the thermometers may be graduated in pounds to avoid translation. A series of pressure gauges may also be used, and will correspond with the thermometer readings at the same section. The rate of expansion can be found in this manner as an

Fig. 1.

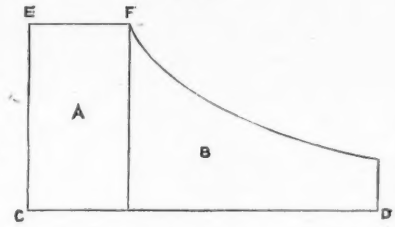
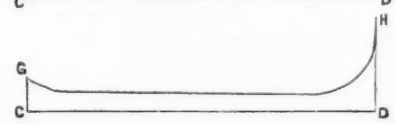


Fig. 2.



aid in fixing upon the dimensions and proportions of the several parts. Where superheated steam is employed the difference of the readings of the pressure gauges and of the thermometers will show the extent to which the superheat is retained as the steam travels through the turbine.

The constancy of the conditions in a turbine on a steady load renders such methods of investigation easy and reliable, in which the turbine differs from the reciprocating engine, the results from which by any similar method would be at least speculative only.

In the flood of literature appearing during the past 10 years on steam turbines, this class of information has been singularly deficient.

Tests giving steam consumption per KW.-hour may induce purchasers to buy turbines, but they are comparatively as valueless as the photographs of high-speed boats for any information they afford on the principles underlying the turbine, and the action in it of the working fluid.

The B.H.P. for a turbine is so easily got that the I.H.P. as obtained from the reciprocating engine may be dispensed with. The chief value of an ordinary indicator diagram is to show the action of the steam in the cylinder, and it is the action of the steam, especially in the long variety of the turbine, that is now of more serious interest. As already surmised, the effect of superheat is probably obtained at an earlier temperature than is necessary in reciprocating engines, but better assurance of this would be gained by a series of positive records of temperatures and pressures taken in the course of the length of a turbine. There are many who think that turbines have grown too long, and that the larger ends are mere churns; that the claims for extended expansion are somewhat overdrawn and that more modest dimensions would serve. Such questions would be better answered were information forthcoming in the direction indicated. With the growing number of makers it is hardly likely longer to be neglected.

If already obtained and not published, it may account to some extent for the slow progress made by this most interesting of steam motors.

BUSINESS NOTES.

Westinghouse Gas Engine Contracts.—The Sir Hiram Maxim Electrical Engineering Co., Ltd., have placed an order with the British Westinghouse Co., for the following plant:—One 100-KW. gas engine and generator; one 100-KW. gas engine direct-connected to two 50-KW. generators; one balancer-booster set; one switchboard. Messrs. Frank Suter & Co., Ltd., as general contractors to the Walthamstow U.D.C., have placed an order with the British Westinghouse Co. for three additional 250-B.H.P. producer gas engines to be used in the extension of the Walthamstow plant for the new tramway service. This constitutes the fifth order for these gas engines to be used by the Walthamstow Council, which now has altogether ten Westinghouse direct-coupled gas engines.

Electrical Machinery Exports.—There was a falling off last month in the exports of British electrical machinery, the returns showing a total of only £30,066, bringing up the exports for the two months ending with February, to only £63,792, as compared with £75,681 in the first two months of 1903.

Electrical Wares Exported.

Week ending Mar. 24th, 1903.		Week ending Mar. 22nd, 1904.	
Amsterdam	Value £60	Alexandria	Value £219
Auckland	20	Amsterdam	50
Beira	190	Autofagasta	80
Bombay	311	Auckland	68
Buenos Ayres Teleg. cable	600	Bangkok	114
,, Teleph. cable	170	Brisbane	135
Calcutta	1,781	Calcutta	471
,, Teleg. mat.	153	,, Teleg. mat.	155
Cape Town	1,872	Callao. Teleg. cable	93
,, Teleg. mat.	420	Cape Town	372
Christchurch	24	Colombo	157
Colombo	170	Delagoa Bay. Teleg. mat.	1,788
Copenhagen. Teleg. mat.	30	Durban	857
Delagoa Bay	31	,, Teleg. mat.	648
Durban	1,349	East London	750
,, Teleg. mat.	3,801	Fremantle	54
Fremantle	116	,, Teleg. mat.	73
Gibraltar	142	Gibraltar	148
Hamburg	25	,, Elec. machinery	523
Hong Kong	97	Gothenburg	90
Labuan	21	Hamburg	17
Lisbon	13	Hong Kong	94
Madras	725	Launceston	160
,, Teleg. mat.	96	Madras	430
Melbourne	80	,, Elec. machinery	560
Nagasaki	1,788	Malta. Teleg. instruments	190
Nordenham. Teleg. cable	860	Otago	21
Otago	150	Paris	226
,, Teleg. mat.	40	Perth	37
Penang	3,508	Port Elizabeth	29
Perth	123	Rio Janerio. Elec. machinery	2,526
Port Elizabeth	207	Rotterdam. Teleg. wire	12
St. Petersburg. Teleg. cables	1,544	Seychelles. Teleg. apprts.	179
,, Teleg. mat.	860	Shanghai. Teleg. mat.	46
Shanghai	40	Singapore	9
Singapore	135	Sydney	73
Suez. Teleg. mat.	225	,, Teleg. mat.	47
Sydney	226	Valparaiso	84
Valparaiso. Teleg. cable	2,305	Wellington	256
Wellington	237	,, Teleg. mat.	510
Zanzibar	84	Yokohama	1,397
Total	£24,519	Total	£13,727

Foreign Goods Transhipped.

Gothenburg. Elec. appa.	Value £48	Durban. Telephones	Value £1,500
New York. Elec. appa.	104	East London. Elec. mat.	137
Total	£152	Total	£1,637

Patent Law in Australia.—Messrs. W. P. Thompson and Co., patent agents, of Liverpool, write:—

Your readers will probably be interested in hearing that the Governor-General in Council of Australia has decreed in accordance with the new Federal Law, that patent applications for Australia can now be formally made at the Custom House of the capital city of each State. Applications so filed will be marked with the date, hour and minute of receipt, and the applications will be subsequently recorded at the Patent Office as having been filed at that date. Applications thus filed will not be merely taken in order of their dates, but they will be held to be dated as far as regards novelty, from the date of actually filing at the Custom House, unless dated under the convention. Under the convention nearly all the principal countries and colonies have agreed to grant the right to a patentee who has filed an application for a patent in one of the countries or colonies, to date any or all the other applications he may make for the same invention in other realms during the year, as of the date of his original first application. The application in Australia can either be a provisional one or a complete. The fees and stamp duties are just double those of an application for Great Britain and Ireland.

Brush Contracts.—The Brush Electrical Engineering Co. have secured the following contracts:—

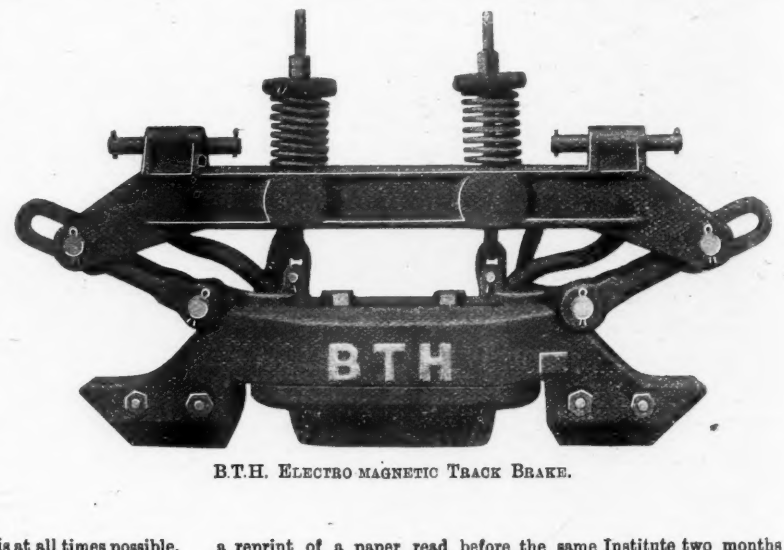
Cardiff Corporation Tramways (per British Westinghouse Co.).—15 pairs maximum traction trucks.

Durban Harbour Board.—300-KW. dynamo and switch panels.

The Motor-Car Show at Islington. — To-morrow is the closing day of the ninth annual automobile show which is being held at the Agricultural Hall, Islington, under the auspices of the Automobile Club. It is undoubtedly the biggest show of the kind that the Agricultural Hall has seen, is a businesslike and compact affair, and is a credit to Messrs. Cordingley & Co. (of the *Motor-Car Journal*), the promoters. Though it is undoubtedly representative of motor-car industry, and illustrates the enormous progress which the business is making, the electromobile exhibits are unfortunately very few and far between, though there is a large variety of exhibitors of ignition devices, batteries, charging boards, and other electrical details of a like nature. The electrical vehicle exhibits are provided by the London Electromobile Syndicate, Messrs. Bath and Son, of London and King's Lynn, Messrs. Morgan & Son, the Anti-Vibrator, Ltd., of Croydon, and the Lancaster Motor Garage. Among the exhibitors of the small devices mentioned, we noted Messrs. Van Raden & Co., Messrs. Sutherland & Marcuson, the Sola Accumulator Co., the Pfluger Accumulator Co., Messrs. Pritchetts and Gold, Messrs. Peto & Radford, the Max Accumulator Co., the Electric Battery Co., the A.B.P. Accumulator Co., the Electric Ignition Co., Messrs. Salsbury & Son, Mr. F. C. Blake, Messrs. J. Lacoste & Co., Messrs. Greenberg & Co., the British Steam Traction Syndicate, Messrs. J. C. Fuller & Sons, and the Prested Miner's Gas Indicating Electric Lamp Co., Ltd. Messrs. Geipel & Lange are showing their Vulcan electrical speed indicator. Messrs. Crossley Bros., the National Gas Engine Co., Messrs. Bilbie, Hobson and Co., and Messrs. Kynochs all exhibit small gas engine driven electric generating sets. There are more than 300 exhibitors. Some of the racing machines for the eliminating test in connection with the British team for the Gordon-Bennett race are on view, as well as many new heavy vehicles for municipal purposes. For those who take an interest in the progress of aerial flight, a collection of flying machines and other kindred exhibits of models, &c., will be found in the North Gallery Annexe. This section has been organised by the Aero Club of the United Kingdom.

New Electro-magnetic Track Brake.—The problem of efficiently controlling a heavy tramcar continues to receive close attention at the hands of those interested in the application of electric traction. The B.T.H. Co. are the latest in the field with a device to attain this desirable end. This takes the form of an electro-magnetic track brake, and consists of suitable electro-magnets mounted in proximity to the track, and which, when energised, are drawn down on to the rails. The current is generated by the motors acting as generators, and the brake action results both from the magnetic brake-shoes and the retardation due to the motors acting as generators.

The brake consists of a cast-steel shoe suspended from a bracket fastened to the side of the car truck. This bracket is well ribbed and braced, and is provided with heavy lugs which take the thrust through cast-steel links in compression. The bracket is formed to act as the seat for two compression springs, which support the brake proper by wrought-iron eye-bolts. These springs keep the brake-shoe free from the track when it is not in use. The brake-shoe itself consists of a substantial steel casting with a cored recess into which the magnetising coil is placed. A brass cap or cover is placed over this coil, and so fitted as to form a water-tight protection. A steel core extends through the coil providing two magnetic circuits, each of which is completed by the section of rail immediately under the brake shoe. The terminals of the magnetising coil consist of well insulated flexible wires brought out through bushed holes in the top of the cast-steel frame of the shoe. They consist of two wires in duplicate, and are of sufficient length to extend from the end of the coil winding to the car underframing without a joint. Each shoe is provided with wearing plates for contact with the rails. These plates are steel castings, held in place by machined bolts so placed that the plates may be renewed without removing the brake shoe from the truck.



B.T.H. Electro magnetic Track Brake.

In the case of a double-truck car, the magnetising coils in the two trucks are placed in parallel, and an injury to one of them would still leave half the braking effort available. The chances of skidding the wheels are claimed to be greatly diminished with this brake, since the track shoes are in no way connected with the wheel brakes, and an independent action of the hand-brake is at all times possible. The adhesive force between brake-shoe and rail is about one ton for each magnet, thus ensuring accurate control, even on wet and greasy rails. The brake is applicable to practically all types of car.

In order to demonstrate the efficiency of the brake as an emergency and service brake, a series of tests have been carried out under actual working conditions on one of the heaviest routes in the country. A four-wheel double-deck car with two motors was used, and the following results were obtained:—

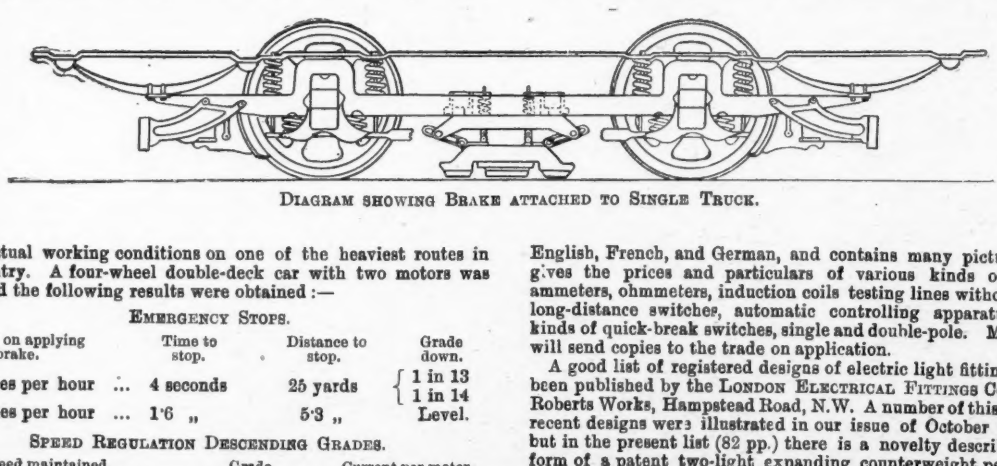


Diagram showing Brake attached to Single Truck.

Emergency Stops.

Speed on applying brake.	Time to stop.	Distance to stop.	Grade down.
25 miles per hour ...	4 seconds	25 yards	1 in 13 / 1 in 14
14 miles per hour ...	1·6 „	5·3 „	Level.

Speed Regulation Descending Grades.

Speed maintained.	Grade.	Current per motor.
5 miles per hour... ...	1 in 13 / 1 in 14	4 amperes.
5 miles per hour... ...	1 in 17	3·5 „
5 miles per hour... ...	1 in 45	2 „

The first test represents extreme conditions, such as a car running away down a steep incline; and, considering the gradient and the high speed, the stop was very rapid, being made in about 2½ car-lengths. The second test would correspond to the case of a car travelling at a moderate speed, and obliged to pull up suddenly. It will be seen that such a stop can be made in less than a car-length.

The second table is interesting, inasmuch as it shows that a low and even speed can be maintained when the car is coasting down the steepest grades, so that it is always under perfect control. If necessary the car can be brought to a stop by further movement of the controller handle, and held at rest by the wheel brake.

For Sale.—On March 29th and 30th, Mr. T. Kinsman is to offer for sale by auction various plant and tools at the electricity station at St. Austell. See our advertisement pages for particulars.

Catalogues and Lists.—Messrs. David Rowell and Co. have issued a catalogue of their fencing, iron and steel structures, engineering works, and so on.

A circular of electrical installation plant and accessories, with several descriptive estimates for electric lighting and telephone work has reached us from Messrs. Henderson, Blanchet & Co, of 19, Old Queen Street, Westminster, S.W.

The Lahmeyer Electrical Co., Ltd., of New Oxford Street, W.C., have just published an excellent illustrated list (No. 13b) of 48 pp., describing fully and giving diagrams and prices of controllers and other apparatus for electrically driven cranes, hoists, lifts, and other variable-speed machines.

A list of small continuous current arc lamps has come to hand from M. L. Bardon, of Clichy (Siene).

Two neat brochures have come to our hands from the British Westinghouse Co. One is entitled "Three-Wire System for Variable-speed Motor Work," and is a reprint of a paper read before the American Institute of Electrical Engineers 16 months ago by Mr. N. W. Storer. The other, written by Mr. B. G. Lamme, is also a reprint of a paper read before the same Institute two months earlier, describing the "Washington, Baltimore and Annapolis Single-phase Railway."

Mr. James Littauer of 72, Finsbury Pavement, E.C., has sent us a copy of the latest price list issued by Dr. Paul Meyer, of Berlin, whose sole agent he is for the United Kingdom. The list is printed in English, French, and German, and contains many pictures, it also gives the prices and particulars of various kinds of volt and ammeters, ohmmeters, induction coils testing lines without current, long-distance switches, automatic controlling apparatus, various kinds of quick-break switches, single and double-pole. Mr. Littauer will send copies to the trade on application.

A good list of registered designs of electric light fittings has just been published by the London Electrical Fittings Co., Ltd., of Roberts Works, Hampstead Road, N.W. A number of this company's recent designs were illustrated in our issue of October 16th, 1903, but in the present list (82 pp.) there is a novelty described in the form of a patent two-light expanding counterweight pendant, the range between the holders varying from 12 to 24 in.

Mr. Fernand Espir, of 3, East India Avenue, has placed before us a new list of bi-metallic wire for electrical purposes. He is sole English agent for this wire, which is manufactured by the Compagnie des Trefileries du Havre, of Paris. Some interesting particulars are set out of examples of the wires generally used in the construction of overhead telegraph and telephone lines with bare wires. Tables of coefficients of different conductors follow.

Some new lists of distributing fuseboards are being sent out by Messrs. Ernest F. Moy, Ltd.

Messrs. Holden & Brooke, Ltd, of Manchester, have issued a new 16-page pamphlet detailing very fully the advantages to be derived from the adoption of the Brooke's new steam trap which they have lately introduced. The increasing demand for steam traps generally has already led to the placing of a number of orders for the Brooke's trap. It is claimed that the device is essentially a non-dribbling trap, dribbling being avoided by the special construction, which is fully explained with excellent illustrations in the pamphlet.

A circular issued by the Cape Asbestos Co., Ltd., gives some details respecting their blue asbestos mattresses for boilers, and

their application. Views are given of the M.E.S. Co.'s station at Willesden, and the St. Andrew's Cross station at Glasgow, where these mattresses are in use.

Book Notices.—*The Indian Electricity Act, 1903.* By J. W. Meares, M.I.E.E., Fellow of the Royal Astronomical Society, Electrical Engineer to the Government of Bengal. 1904. 10s. 6d. net. Calcutta: Thacker, Spink & Co. As there is great scope in India for electrical enterprise, it is desirable that engineers in this country should be aware of the provisions of the law in that part of the British Empire regulating the supply of electricity. Only last year a new Act was passed making considerable changes in the old law, which make it more in accordance with modern requirements. Under this Act, electrical progress should be much more rapid than it has been in the past, and Mr. Meares has endeavoured in the present volume to explain the provisions of the Act in the light of the peculiar conditions prevailing in India. The text and rules are set out in full, and valuable notes are added by the author. The introductory chapter gives a most interesting sketch of the history of electrical legislation in India, which ought to be read by all who take an active interest in the reform of our electrical laws at home. It will be seen that India has now obtained some of the reforms which are urgently demanded, but as yet not granted, in this country. The work is carefully prepared, and the exposition of the law is all the more clear by being given by a practising engineer familiar with the conditions under which electrical work is carried on.

"Oil Engines: Their Selection, Erection and Correction," by W. A. Tookey. London: Merritt & Hatcher, Ltd. 1s. net.

"Index of the Technical Press." London: *Engineering.*

"La Télégraphie sans fils," by A. Broca, 4 fr. "Essais Industriels des Machines Electriques," by F. Loppé, 8 fr. Paris: Gauthier-Villars, 1904.

Falsifying Time Sheets.—An electrician named Fred W. Sheppard, employed by Messrs. Royce, Ltd., electrical engineers, of Hulme, was sentenced to two months' hard labour at Manchester on March 18th, for obtaining £2 10s. by falsifying workmen's time sheets.

Dissolutions and Liquidations.—A compulsory winding-up order having been made against the McGuire Manufacturing Co., Ltd., upon the petition of the Electric Equipment and Securities, Ltd., the statutory meetings of the creditors and shareholders were held last Tuesday at Carey Street. Mr. Winearls, Assistant Receiver, reported that accounts had been filed showing unsecured creditors £6,871 13s. 6d., fully secured creditors, £6,317 10s. 6d. (securities valued at £8,140 6s. 5d.), and preferential claims £76 0s. 9d., making a total indebtedness of £13,265 4s. 9d. The assets were valued at £5,540 1s. 3d., and consisted of cash, £17 5s. 4d., stock, £2,000, machinery, £1,500, fixtures and fittings, £200, and the estimated surplus of £1,822 15s. 11d. from the securities held by creditors. The deficiency of assets to meet the liabilities of the company is returned at £1,407 13s., and the total deficiency to the contributories at £25,267 3s. The company was formed on February 19th, 1901, under the name of the European McGuire Manufacturing Co., Ltd., with a nominal capital of £20,000 (subsequently increased to £40,000) to acquire and work patents, *inter alia*, for electric motor trucks, sweepers and fenders, and with that object to enter into an agreement with Mr. Frank Charles Buxton for the purchase by the company of (1) the rights of W. A. McGuire for Europe and the British Colonies (excepting New Zealand and Australia and North and South America) in certain patents belonging to McGuire and any other patents which he might thereafter take out by way of improvements, with the right to use the name of McGuire and to act as agents for the McGuire Manufacturing Co., of Chicago; (2) All (if any) rights and privileges agreed to be sold to Buxton by McGuire; and (3) the benefit of all profits arising from contracts which Buxton had entered into as agent for the McGuire Manufacturing Co. The consideration was £11,000, to be satisfied by the allotment of 11,000 fully paid-up shares, of which 5,000 were to be allotted to McGuire, and 6,000 to Buxton. By the same agreement Buxton was to be the managing director of the company for three years from January 1st, 1901, during which period he was to devote the whole of his time to the company, and be subject to the board of directors at a salary not exceeding £500 per annum. The qualification of directorship was the holding of 100 shares. The company proceeded to allotment on May 7th, 1901, and in all 12,862 shares were issued for cash. A prospectus dated May 22nd, 1901, offering for subscription 5,000 shares, was printed, but was not sent out to the public. In May, 1903, proceedings were commenced by Mr. Harold Jowers (who was on the board of directors from September, 1902, to May, 1903), against the company and Buxton and another director for the recission of his contract to take 5,000 shares, and the return of £5,000 subscribed by him for the same, on the ground of misrepresentations of Buxton and the other director. The action was eventually compromised on the terms that Jowers was to receive a promissory note from the company for £1,500, payable 12 months after date, and to retain the 5,000 shares, each side paying their own costs. The company acquired in July, 1901, a lease for 999 years from 1861 of Elton Fold Works, Bury, from the Lancashire and Yorkshire Bank for £6,000. The business was commenced, a number of orders for trucks being subsequently obtained from the British Westinghouse Co., and the British Thomson-Houston Co., including trucks for the Great Northern and City Railway, London County Council tramways, Bury Corporation tramways, and the Darlington tramways. The first and only accounts of the company, which were made up to December 31st, 1902, showed a loss of £2,721 8s. On September 3rd, 1903, the petitioners advanced £1,500 for 60 days at 6 per cent. on the security of a charge on the whole of the works (subject to a mortgage of £4,000), and all book debts, present and future. The loan had not been repaid, and the petitioners had obtained judgment in respect of it, and their other advances, amounting in all to £2,000 16s. 10d. and £4 14s. costs, on which the petition was based. Execution was levied on behalf of the petitioners at the company's works at Bury on February 8th, 1904, and the sheriff was in possession at the date of the appointment of the Official Receiver, as Provisional Liquidator. After considerable negotiation an arrangement was made under which the petitioners instructed the sheriff to withdraw, and the Westinghouse Co. paid to the Official Receiver £1,000 on account of their contract, and the special manager, under the direction of the Official Receiver, had been carrying on the business with a view to the completion of the contracts.

At both meetings there was a difference of opinion as to the appointment of a liquidator, and the point will be referred to the Court for decision.

List of Creditors over £10.

Alldays & Onions, Ltd., Birmingham	£22 10 6
Austen & Dodson, Sheffield	97 1 5
John Baker & Co. (Rotherham), Ltd., Rotherham	288 14 0
Walter Brierley, Bury	21 0 0
Brydon & Co., Manchester	27 7 11
F. C. Buxton, London	550 10 0
F. R. Cass, Bury	14 9 6
Samuel Cook & Co., Bury	60 1 0
Electric Equipment and Securities, Ltd., London	657 10 7
Elton Cap Dyeing Co., Ltd., Elton, Bury	157 15 6
Gas Committee, Bury Corporation, Bury	57 15 6
Hadfield's Steel Foundry Co., Ltd., Sheffield	390 17 4
Hall & Pickles, Manchester	55 19 0
Hartley & Co.	164 10 0
Hutchinson Bros., Bury	10 2 8
Inland Revenue	12 16 7
Harold Jowers, Haywards Heath	1,515 0 0
W. S. Laycock, Ltd., Sheffield	11 4 0
Maguire & Baucus, London	424 10 0
S. Marsden & Sons, Ltd., Manchester	158 19 8
McGuire Co., Ltd., Chicago, U.S.A.	69 17 1
C. M. Merchant & Sons, Bury	106 14 6
G. F. Milnes & Co., Ltd., Hadley, Salop	27 10 2
Samuel Osborn & Co., Ltd., Sheffield	105 4 1
Owen & Dyson, Rotherham	432 0 0
H. Pickup, Radcliffe	11 12 10
W. Roberts & Sons, Bury	127 18 8
D. Rollo & Co., Liverpool	211 18 0
Street Railway Journal, London	20 16 8
Tiliza Bronze Co., Oswestry	35 12 7
Tramway and Railway World, London	27 16 8
Vacuum Oil Co., London	16 19 0
Chas. Walmsley & Co., Ltd., Elton, Bury	11 1 4
Wilson, Bristow & Carpmael, London	90 0 0

Fully Secured.

British Electric Car Co., Ltd., Manchester	244 9 9
Earl of Derby, Bury	349 4 10
Electric Equipment and Securities, Ltd.	1,528 7 0
Lancashire and Yorkshire Bank, Ltd., Bury	4,083 6 8
Lancashire and Yorkshire Railway Co., Bury	49 16 11
Wm. Chaplin, London	59 5 4

Preferential.

Frank Chas. Buxton, London	422 6 11

Creditors of Braby & Tomlinson, Ltd (*in liq.*), should send particulars of their debts, &c., to Mr. A. B. Bryden, 23, Bucklersbury, E.C., the liquidator, by April 9th.

Blackpool Tramways.—The Lancashire Chancery Court is being petitioned by the Blackpool, St. Annes and Lytham Tramways Co., Ltd., and the Blackpool Electric Tramway (South), Ltd., to sanction a reduction of the capital from £150,000 to £125,000. It is proposed to do this by extinguishing £20,000 of the ordinary capital and £5,000 of the preferred capital. The company was formed to take over the tramways from Blackpool to St. Annes and Lytham, which were formerly run by gas traction, an Act of Parliament having been obtained in 1900 for their conversion into a system worked by electricity. They were not able to carry that out, because it required a large sum of money to do the work of electrification, and the Blackpool Electric Tramway (South), Ltd., was formed, as an outside speculation, with a view to obtaining a controlling interest in the other company, which it ultimately did. The two then came together, and the South Co. agreed to electrify the tramway system and to buy up and get rid of the old debentures, which consisted of £40,000 first debentures and a portion of an authorised issue of second debentures. In consideration of that they were to receive £150,000 first debentures, a balance of £10,000 preference shares which were unissued, and a new issue of £50,000 ordinary shares. The work was carried out, and the position now was that the former company had an issued capital paid up of ordinary shares, £100,000, and preference shares, £50,000, and a debenture issue of £150,000 as against which the only serious asset was the tramway system. The object of the present application is to put the company on a proper footing. The petition was presented to the Court on Monday last, when counsel for the Blackpool, St. Annes and Lytham Co. informed Vice-Chancellor Hall that it was proposed to reduce the ordinary shares from 20s. to 16s. per share, and the preference from 20s. to 18s. The Court was further informed that the Electric Tramways (South) Co. was formed ostensibly to buy the whole of the assets of the other company, but it was unable to do that. It had, however, £150,000 debentures and a sufficient majority of the shares to practically give it control. Complications arose through the contractors who were engaged to make the line who had issued to them one class of preference shares and the whole of the ordinary shares, but they could not carry on their work, and in the end the shares were sold to the shareholders in the South Co. The reduction in capital which was asked for was consequent upon the reduction in the other case.

Trade Announcements.—The Rhodes Electrical Manufacturing Co., Ltd., inform us that they have established a branch office at 35, McAlpine Street, Glasgow, for the sale of their

manufactures (electric motors and dynamos) for the whole of Scotland, under the management of Messrs. James T. Donald & Co., Ltd. All inquiries for this district will be dealt with at that address.

Messrs. Edward G. Herbert, Ltd., announce that owing to the rapid growth of their business, they have moved from Cornbrook Park Works to a larger works, Rosamond Street East, Manchester, where all communications should be addressed.

Messrs. Newton Bros., electrical engineers and contractors, have taken more commodious premises at 21, Market Place, Derby, as offices, and all communications should be addressed there.

Mr. H. S. Jacques has commenced business as H. S. Jacques and Co., electricians, &c., at 21, Duke Street, Whitehaven. For the past 11 years he has been connected with Messrs. John Whittle & Son, Ltd., of that town, and has carried out a large number of installations.

High Voltage Electric Bell.—Fire or burglar alarms, danger signals, &c., depend in the main on the satisfactory state of the battery. If the battery is neglected or run down, even the best alarm bell will be of no use. These shortcomings have been successfully overcome by the International Electric Co., of 55, Redcross Street, Barbican, who have just brought out a gas and waterproof iron-cased bell, which can, without the insertion of a separate lamp or other resistance, be connected direct to any electric light supply, up to 250 volts. It stands to reason that in this case the source of supply is available at any moment, especially when it is wanted; and the signalling is naturally distinct and reliable. The bells are stocked for 100 to 110 volts, and 200 and 220 volts, but can be made to suit any voltage up to 250. We should say that a good many of our readers will be interested in this new departure.

Deed of Assignment.—Creditors under the deed of assignment executed by H. J. Leeves-Johnson and C. W. Fitzer (Johnson & Fitzer, electrical engineers, Twickenham), should send particulars to the trustee, Mr. H. McLellan, Devonshire Chambers, Bishopsgate Street Without, by March 30th.

New Arc Lamp Mechanism.—Some weeks ago we referred under this heading to a new device of considerable promise, having the minimum of working parts—two, to be precise—and of great simplicity. Since then we have seen the lamp in operation at Faraday House, by invitation of Mr. L. C. H. Mensing, the inventor, who, as is well known, has made a special study of arc lamps for twenty years and more. The model in question was operated in our presence as an ordinary open arc lamp, a flame arc, and an enclosed arc—all on direct current; the lamp, however, is readily adapted to alternating current, by the substitution of a suitable shunt coil for that used with direct current. As an open arc the lamp was burned on a total voltage of 60 volts, with 40 to 45 volts across the arc, and 7 to 10 amperes; as enclosed arc, on 100 volts, with 60 volts across the arc, and 7 amperes.

The grip with which the carbons are held is such that striking the frame with a metal bar (or an umbrella handle!) produced not the slightest effect on the arc; yet the feeding is very sensitive.

Seeing that the model in question is the very first of its type, and that the design has not yet passed through the usual stages of experiment and improvement of details, the results attained by Mr. Mensing are remarkable, and lead us to believe that, given time and opportunity to remedy the slight defects unavoidable in a "first edition," he will be able to bring it to a very high degree of perfection. We hope in a later issue to give full details of the construction of the lamp.

Bastian Mercury Vapour Lamp.—On Saturday last a demonstration of this lamp took place at the offices of Messrs. Rumney & Rumney, 39, Victoria Street, S.W. An account of the lamp will appear in our next issue.

LIGHTING AND POWER NOTES.

Arbroath.—The Empire Electric Light and Power Co., which is negotiating with the T.C. for the transfer of its prov. order, has refused the amended proposals put forwarded by that body.

The sum of £200 offered by the Council to Messrs. Buchan and Hogarth for their services in regard to the scheme, has been refused by them, and an intimation given that they would accept a fee of 375 guineas, or as an alternative refer the fixing of the fee to an arbitrator. This offer the Council has not accepted.

Ashford (Kent).—In response to the request of the electric lighting company, the U.D.C. has consented to fix the periods at which the Council may purchase the undertaking at 21, 28 or 35 years, instead of 21 years, as previously decided.

Beeston.—The canvass of the district on the electric lighting scheme has proved satisfactory, and the Council has resolved to take the matter in hand at an early date.

Bournemouth.—On the 16th inst. an exhibition of electrical appliances, under the auspices of the Bournemouth and Poole Electricity Supply Co., was opened at the Hotel Mont Dore, by Mr. Beale, the mayor, in company with Mr. Bacon, the mayor of Poole. After the ceremony luncheon was served at the hotel. This is the first exhibition of its kind held in the borough, and is due to the enterprise of the Electricity Supply Co. whose undertaking, after various stages of trouble and difficulty, is now in a prosperous condition. Many novelties were shown at the stalls, including appliances for lighting and domestic use and various power purposes. A number of local firms exhibited, and several kinds of electro-medical apparatus were on view. The exhibition closed on the 23rd inst., the prices for admittance were 6d., and after 6 p.m., 3d.

Brighton.—The T.C. has resolved to erect a new converter house, cable culverts, &c., adjoining the works in North Road, and has accepted the tender of Messrs. Rowland Bros., of Horsham, at £5,699.

Carlisle.—The T.C. has adopted the recommendation of its E.L. Committee to extend its mains to Caldewgate at a cost of about £430, when the agreement now pending with the North British Railway for a supply of energy, which is estimated at 60,000 units, has been entered into. The Sub-committee appointed to consider the system of charging for energy at present in operation has recommended that the present rates be continued.

Chatham.—The Admiralty has decided to erect an electric power station at the Dockyard at a cost of about £50,000, and has placed orders with Messrs. Bruce Peebles & Co. for the complete equipment.

The Government has also intimated that it will shortly erect a new electrical school, which will be in connection with the School of Military Engineering.

Dartford.—The U.D.C. has decided to supply energy for the lighting of the market stalls at 1s. 2d. per week per 250-C.P. lamp, and 10d. per week per 130-C.P. lamp.

Dorking.—The T.C. has resolved to increase the amount of the loan agreed upon recently for mains extensions to £3,000. The Council also agreed to pay Messrs. Edmundsons £8,000 in respect of the work done in connection with the scheme and £260 to Mr. Trentham on account of his fees.

Dublin.—The City Auditor in his report states that the depreciated value of the buildings and plant of the Fleet Street scheme is £28,790, and it is proposed to transfer this amount to the Fleet Street suspense account, which leaves the remainder of the undischarged balances of loans at £28,784, the estimated present value of the buildings and plant taken over as a capital charge against the Pigeon House scheme, in addition to amounts borrowed for the special purposes of that scheme. The committee will recommend to the Council that the repayment of the amount charged to the suspense account shall be effected within seven years from October 1st last, instead of the time originally sanctioned. If this is not carried out it is stated that the whole amount of the unpaid balances of loans must be charged against the new scheme, which would then be unduly weighted with unproductive capital charges.

Dundee.—Messrs. James Scott & Sons, who have works in the city, have decided to replace their steam power by electricity, and altogether the new plant is estimated at about 2,000 H.P. The firm will lay down their own machinery, and propose to install Westinghouse gas engines for driving the generators.

Falkirk.—The N.B. Railway are inquiring as to a supply of electricity from the Corporation works to the Grahamston Station goods yard and Falkirk (High) Station. Terms have been asked for a supply of at least 35,000 units per annum. The matter has been remitted with powers to the convener, the town clerk and the electrical engineer to arrange with the company.

Festiniog.—The dispute with Mr. Yale, the manager of the E.L. Co., is stated to have now been settled. The Council alleged that the light did not come up to the standard laid down in the agreement, but the maintenance of the lighting has been recently transferred into the hands of the Council.

Germany.—It has been decided to erect an electricity works at Rudesheim.

Gillingham.—The T.C. has decided upon alterations in the scale of charges for energy. Those who prefer to continue the maximum demand system at 7d. and 2d., as at present, may do so, but the Council has decided also to supply on a flat rate of 4½d. per unit. For slot meters the charge will be 5½d. instead of 6d. per unit.

Glasgow.—The Electricity Committee of the Corporation reports that it has received a further deputation from the Pollockshaws T.C. with reference to the application to the B. of T. by the Clyde Valley Electrical Power Co. for a prov. order to supply electricity within the burgh. Provost Wilson stated that since the last conference, the Clyde Valley Co. had requested the B. of T. to dispense with the consent of the burgh to the granting of the order; and the deputation desired to know whether, and upon what terms, the Corporation would, in the event of the burgh successfully opposing the company's application, and themselves obtaining an order, be prepared to take a transfer, and supply electricity within the burgh. The matter has been remitted to a special committee.

Contracts have been placed by the T.C. for the necessary work in connection with the erection of the northern section of the Port Dundas generating station.

Grimsby.—At a recent meeting of the Corporation E.L. Committee in connection with the opposition which the Corporation is raising to the Lincolnshire and Yorkshire Electric Power Bill,

it was decided to retain the services of Dr. Kennedy, electrical expert, to work up the case at a fee of 50 guineas, with additional remuneration if he is required to give evidence in either House. The Committee also resolved to instruct counsel. It was stated that the cost of its opposition to the scheme would be about £500 or £600. The value of the Corporation power station and plant, which the opposition is intended to safeguard, is £80,000.

Hampton.—The U.D.C. has decided to accept the tender of the Twickenham and Teddington Electric Supply Co. for the public lighting, and to give the Gas Co. notice to determine its contract from September 29th next.

Heckmondwike.—The U.D.C. has resolved to reduce the price of energy for lighting purposes to 4d. per unit.

Hindley.—The U.D.C. has resolved to apply to the B. of T. for an extension of time for the carrying out of its E.L. order.

Hucknall-Torkard.—The U.D.C. has decided to ask the Derbyshire and Notts. Electric Power Co. for its lowest terms for supplying electricity at any given point in the district, without fixing any minimum, and that the Hucknall Colliery Co. be also asked if it would be prepared to supply electricity, and upon what terms.

Inverness.—Messrs. Edmundsons are to carry out the electric lighting of the town, and a site has been selected. The company are bound under a penalty to complete the work before December next.

Italy.—A concession has recently been granted for the electric lighting of Amalfi.

Kalk Bay (S.A.).—The Council has decided to introduce a Bill into Parliament for powers to supply electricity for lighting and power purposes.

Keynsham.—The B. of T. has notified the R.D.C. that it might dispense with the Council's consent, and let the petitioning company proceed with the E.L. order; a deputation was appointed and discussed the matter with the Board, and at the next meeting a motion will be put forward giving the Council's consent to the order being carried out. The districts affected are Keynsham and Saltford, and the company has agreed to lay its wires underground where possible, and to reduce the charge for energy from 8d. to 7d per unit.

Leek.—The U.D.C. has fixed the following scale of charges for energy for power purposes:—650 units and over per quarter per kilowatt demanded, 1½d. per unit; 520, 1¾d. per unit; 390, 2d. per unit; 260, 2½d. per unit. For motors running intermittently, and consuming less than 260 units per quarter, 2½d. per unit.

Leicester.—The report of the last half-year's working of the electricity department shows a total income of £15,676, and after deducting for working expenditure, a gross profit of £8,874 has been obtained. Interest amounted to £3,380, and sinking fund £2,545, leaving a net profit of £2,948, an increase of £262 for the half year, and making an accumulated profit of £9,750. The switchboard at the town office which was burnt, was replaced at a cost of £1,030, and has been written off. £854 was expended on renewal of meters, and £1,358 in the relaying of a trunk main. Some £300 more than the profit balance has been expended, leaving a capital to carry forward of £6,507.

London.—Shoreditch.—At the last meeting of the B.C. a discussion ensued on the recent conference of London municipal authorities convened by the Borough of Hackney, at which a resolution was passed urging the L.C.C. to again apply to Parliament for powers to enable B.C.'s to undertake the wiring and fitting of consumers' premises for electric light and power, and if necessary to borrow money for the purpose.

Mr. Eldridge, chairman of the E.L. Committee, reported that he attended the conference, and that he was the only one to oppose the resolution, but after listening carefully to the arguments put forward, he came to the conclusion that it might not be advisable in Shoreditch. The vote was practically unanimous, and the whole conference would go as a delegation to the Council. The Council, in conclusion, took no action in the matter.

Marylebone.—The petition from the B.C. for leave to introduce new provisions into its Bill to enable a company to manage the undertaking has been considered by the Standing Orders Committee of the House of Commons. The Committee announced its decision to dispense with the Standing Orders, and allow the new provisions to be introduced and considered by the Select Committee, to whom the Bill is referred.

Islington.—The B.C. has decided to make a minimum charge of 11s. 8d. per quarter for energy, and to impose a meter rent of 2s. 6d. per quarter on all consumers whose accounts do not amount to 25s. every three months.

L.C.C.—At the meeting on Tuesday last, the Council decided to advance £26,000 to the Hackney Borough Council for additional plant at the generating station, and to sanction the borrowing by St. Pancras Borough Council of £19,000 for the extension of mains.

The Proposed Loan to Marylebone.—The Finance Committee submitted a fresh report on this subject. It was pointed out that in the Bill now being promoted by the Borough Council, provision was made for the borrowing of money by mortgage, and for the creation and issue of stock by the borough under the Local Loans Act, 1875. The County Council had petitioned against the Bill on the ground that the borrowing clauses should be amended so as to conform with the existing conditions under which the borough councils were empowered to raise money. The borough council had now asked the County Council, subject to the passing of the Bill, to advance £1,365,000 for the purchase money, and had intimated that it would also apply for sanction to borrow £460,000 for the erection of a generating station and the laying of mains. The Committee stated that it desired to continue the policy of providing the funds required on loan by the local authorities, and would regard with grave apprehension any departure from that system in the direction of the creation of separate local stocks. It therefore advises the Council to seek powers in its Money Bill of this year to raise temporarily, in the event of the B.C. Bill becoming law, the loan of £1,365,000, to provide for the payment by that Council to the company, the temporary loan being afterwards made permanent by the issue of stock. A resolution to this effect will be proposed and communicated to the Borough Council.

Bethnal Green.—The Electrical Committee of the B.C., in the course of a lengthy report, state as their reason for deciding to purchase the freehold and leasehold interests of an adjoining area to that obtained for the electricity works, that the present site would be insufficient with the addition of a refuse destructor plant, and that in order to get over the objection of the owner of the property in Marian Square, it was necessary to acquire a greater area than is actually required. The cost of the added area of 38,916 sq. ft. is £8,735.

Hackney.—The Finance Committee of the B.C. submitted, on Tuesday, estimates for £260 for distributing mains.

Honley.—Electric lighting works at Honley, near Huddersfield, designed by Mr. A. B. Mountain, the Huddersfield Corporation's electrical engineer, were formally opened on 21st inst. by Mr. Crowther, the chairman of the U.D.C. The building containing the generating plant forms part of the gasworks, which are also the property of the Council. This has been converted, now forming a suitable electricity works. The main plant consists of one 22-kw. Westinghouse generator, driven by a 35 b.h.p. Westinghouse double cylinder vertical gas engine; a larger set of 40 kw., and of similar design and construction, has also been supplied by the Westinghouse Co. A small 8-kw. dynamo, of the Alliance Electrical Co.'s make, has been installed for supplying energy for lighting during the period of light load. This is driven by an engine which is constantly running for pumping purposes for the gasworks. The switchboard, supplied by the Alliance Electrical Co., regulates the energy generated by the three sets, and also controls the supply for three feeders and the street lights. The mains also have been supplied and erected by the above company, and consist of overhead bare copper wires supported on steel poles, the pressure of supply being 200 volts. The plant is capable of supplying 2,500 8-c.p. lamps, and the total capital outlay will be about £2,400. Mr. Mountain handed to Mr. Crowther a gold key with which to open the works, and that gentleman started one of the sets, Mr. W. Brooks, J.P., switching on the supply to the town. Subsequently the party dined together at the Wheatsheaf Hotel, where several speeches were made.

Lytham.—The U.D.C. has taken the opinion of the ratepayers on the E.L. question. Only 133 replied in favour of the order being carried out by the Council; 797 were against; as to those who were prepared to take a supply, 79 answered in the affirmative, and 816 in the negative.

Maidenhead.—The result of the last year's working of the electric lighting works shows a deficit of about £100; this result comes up to expectations.

Mexborough.—The electrical installations at the Mexborough and Swinton stations of the G.C. Railway were inaugurated on 17th inst. The scheme comprises 44 arcs and 351 incandescents.

This additional load will necessitate extensions at the works to cope with next winter's demand. The demand for energy and the number of consumers have increased over 100 per cent. during the past nine months, and, according to the electrical engineer, Mr. J. Senior, about £5,000 will be required to carry out the extensions, and when completed, it is proposed to reduce the price from from 5d. to 4½d. per unit with no meter rents. The whole of the plant is being driven from steam obtained from the destructor.

Niagara.—The Senate has adopted a resolution requesting President Roosevelt to negotiate a treaty with Great Britain to regulate the diversion of water from Niagara River by electrical power companies. It is stated that the increasing number of power works along the river threatens seriously to impair the beauty of Niagara Falls, and joint action by the two Governments is therefore urgently needed.

Perth (Ontario).—The Perth Electric Co. has recently been purchased by the municipality at a cost of $12,009, and the latter has asked the Legislature to ratify the raising of the money. The Bill was opposed by the Canadian Electric and Water Power Co. on the ground that the city will enter into unfair competition with it, unless the town also purchased its plant, which includes the town waterworks system—the whole valued at $115,000. It was decided to hold the matter over for six months to enable the litigation to be settled, and the Mayor asked leave to withdraw the Bill.

Portugal.—A concession to supply energy for public and private lighting and power purposes for 20 years, within the area of Villa do Conde, Azurara, Caxinas and Poca de Bares, is open for acceptance.

Radcliffe.—The U.D.C. has fixed the price of energy for lighting at 5d. per unit.

Slough and Datchet.—The E.L. Co. has reduced the price of energy from 7d. to 6d. per unit.

Southend-on-Sea.—The E.L. mains are to be extended at a cost of £2,696, and the Pier is to be lit by electricity.

South Lancashire.—The Lancashire Electric Power Co., which obtained its Act of Parliament in 1900 for the supply of electrical energy in bulk throughout Lancashire, south of the Ribble, is erecting its first power station at Outwood, Radcliffe, and will be prepared to supply electricity in bulk in January, 1905. The mains will extend as far as Wigan, St. Helens and Rossendale Valley. It is hoped that many colliery owners in the district will take advantage of this supply and introduce electricity for various purposes connected with mining. If this is done, and electricity takes the place of steam for driving purposes, the smoky atmosphere of this part of Lancashire will undergo a vast improvement.

Spain.—The electricity works at Estella (Navarra) has recently been inaugurated. Water-power is utilised, the present plant comprising a 120-H.P. turbine and a 75-KW. alternator.

Teddington.—Experiments with 120-C.P. Nernst lamps for public lighting are being carried out by Edmundson's Electricity Corporation.

Victoria.—The Cathcart Proprietary G.M. Co. has lately placed an order with the Austral Otis Co., of South Melbourne, for a complete electric lighting and power plant, including boilers, feed pump, surface condenser and air pump. The new plant will furnish sufficient electricity for motors to drive puddlers, the winding engine and a three-throw pump, the latter being capable of lifting 25,000 gallons of water per hour against a total head of 215 ft. The generating set will consist of a vertical enclosed compound engine of 160 B.H.P., coupled direct to a Ganz three-phase generator of 110 KW. The electrical portion of the plant will be carried out on the three-phase system at 500 volts 50 cycles. According to the *Sydney Bulletin*, this is the first instance in Victoria of an individual mine adopting electricity as the motive power for pumping, hoisting and puddling machinery. The plant is expected to be in operation in August.

The *British Australasian* states that a syndicate comprising five electrical engineering firms, incorporated with the Victoria Electric Light, Heat and Power Distributing Co., is offering to supply the Victorian Government and the City Councils of Victoria with electric power at 1d. per unit, Victorian brown coal to be used for generating purposes, and the energy is to be utilised for the electrification of the Melbourne suburban railways and other purposes. If the Government favourably considers the proposal, and undertakes to consume not less than 10,000,000 units annually for at least 10 years, the syndicate offers to send an engineer to make estimates and reports. The syndicate undertakes to spend £500,000 in developing the Victorian brown coal, and laying down machinery. Sir George Sydenham Clarke, ex-Governor of Victoria, recommends a careful consideration of the proposal.

Mr. Angus MacNaughton, chairman of the company, states that they have tested the vast deposits of brown coal at Laverton, 12 miles from Melbourne, and the reports are highly satisfactory. Experts estimated that the coal could be raised for less than 2s. per ton. The ratepayers of Wyndham, Footscray, Williamstown, Brighton, St. Kilda, Port Melbourne and South Melbourne consented at the polls to electricity being supplied in their municipalities. The maximum charge was fixed at 2d. per unit for heat and power, and 4d. for lighting purposes. In December last the managing director of the company, Mr. Holmroyd, proceeded to England with power of attorney to negotiate and deal with the English syndicate.

Walthamstow.—The U.D.C. on Tuesday last approved a plan submitted by the engineer for the extension of the generating station, and it was resolved to invite tenders. Mr. Enright was instructed to report as to the erection of arc lamps in Forest Road. The electrical engineer was authorised to obtain estimates for the supply of the ordinary brakes for the cars, and the Westinghouse electrical brakes. Mr. Enright reported that the extra cost to be incurred on the overhead trolley wire would be about £500. He was instructed to give the necessary order.

West Ham.—At the last meeting of the B.C. it was agreed to charge £17 each per annum for the small arc lamps erected on the Romford Road. The electrical engineer was authorised to issue his final certificates to Messrs. Babcock & Wilcox, Ltd., in respect of their two contracts for the erection of boilers at the generating station. Arrangements were made for the Mayor to open the new generating station, now practically completed. The tramways manager reported that during the first 13 days 7,674 miles were run, and £494 taken in fares.

Willesden.—At the last U.D.C. meeting it was reported that a writ had been issued against the Metropolitan Electric Supply Co. to restrain it from supplying electricity in the parish contrary to the provisions of its Acts and orders. The half-yearly estimates showed that it was proposed to spend £3,995 in lighting, as against £3,225 in the corresponding period of last year. There are small decreases in gas and maintenance of lamps, but an increase of £865 in electric lighting.

Windsor.—The Windsor Electrical Installation Co. has decided to reduce the price for energy from April 1st next, to 6d. per unit, and to allow discounts up to 20 per cent. to those who consume 6,000 units and upwards per quarter.

Wisbech.—The Corporation E.L. Committee has recommended the T.C. to accept the terms of the National Electrical Construction Co., Ltd., for the establishment of E.L. works, subject to the financial position of the company being satisfactory.

TRAMWAY AND RAILWAY NOTES.

Ayr.—The Tramway Committee is to consider the advisability of procuring a prov. order for the purposes (1) of increasing the borrowing powers of the department by £40,000; (2) doubling the line on the south side from the Grammar School to Chapel Park; (3) extending the tramways on the north to the village of Monkton.

A Canadian Electric Railway.—In our "Contracts Closed" to-day we make an interesting announcement respecting an electric railway in Canada. We believe this to be the first electric railway to run in Canada with plant of entirely British manufacture. The railway passes through an agricultural district of Canada, the first portion of which—30 miles—runs from London, Ontario, through the city of St. Thomas to Port Stanley, on Lake Erie. As soon as this line is energised, the remaining portion from London to Hamilton will be electrified on the same system, making a total distance of 160 miles. We are informed that the Ganz system has been adopted, because the guaranteed figures in comparing continuous current, single-phase and three-phase estimates showed a saving of 30 per cent. both in first cost and in running costs in the Ganz three-phase system. The power will be transmitted at 10,000 volts, 25 periods, and will be transformed down to 1,000 volts for the motor-cars, of which there are 10, each motor-car being designed to go at a speed of 30 miles an hour on the level, and 15 miles an hour up grades of 1 in 25. Each car holds 50 passengers, and is capable of hauling either freight or passenger trailer in addition. The line is built partly across private right-of-way and partly across public roads, as is the case with urban railways in Canada and the United States, and considerable interest will await the results in practice, as the line is under contract to be completed in six months from date. The whole of the electrical portion of the plant will be of British manufacture, built at Bruce Peebles & Co.'s works in Edinburgh, who are to be congratulated upon their success.

East Ham.—It is stated that the East Ham U.D.C. last week approved a recommendation for the mutual working of the West Ham and East Ham electric tramways, so as to avoid the necessity for changing at the boundaries of the two districts at Forest Gate, Upton Park and Plaistow.

Liverpool—Southport Electric Railway.—On Tuesday a successful inaugural run took place over this line. A large number of railway magnates, including Sir George Armytage, chairman of the company, Mr. Aspinall, general manager, Lord Stalbridge, Viscount Ridley and Sir Edward Green were present. The distance, 18¼ miles, was done in 29 minutes without a stop.

Metropolitan and District Railways.—In the House of Commons last week, Mr. Gerald Balfour said that both the Metropolitan and the Metropolitan District Railway Cos. had informed him that the equipment of their lines for electric traction was progressing rapidly, and that they expected to be able to run the trains early in next year. There was no statutory limit of time for the completion of the works.

South Shields.—In response to the offers of the T.C. to lease the tramways, only two tenders have been sent in, one by the B.E.T. Co. and the other by a Manchester syndicate. The former asks for a lease of 28 years, and the latter for 42 years.

Swansea.—The T.C. has fixed the following prices for the supply of energy to the tramway company for the working of the tramways:—For a minimum of 200,000 units per annum, 1½d. per unit; the next 150,000 units, $1\frac{3}{16}$d. per unit; the next 150,000 units, 1⅛d. per unit; for the next 150,000 units, $1\frac{1}{16}$d. per unit; for the next 150,000 units, 1d. per unit.

Walthamstow.—The chairman of the D.C. turned the first sod of the electric tramways on the 17th inst.

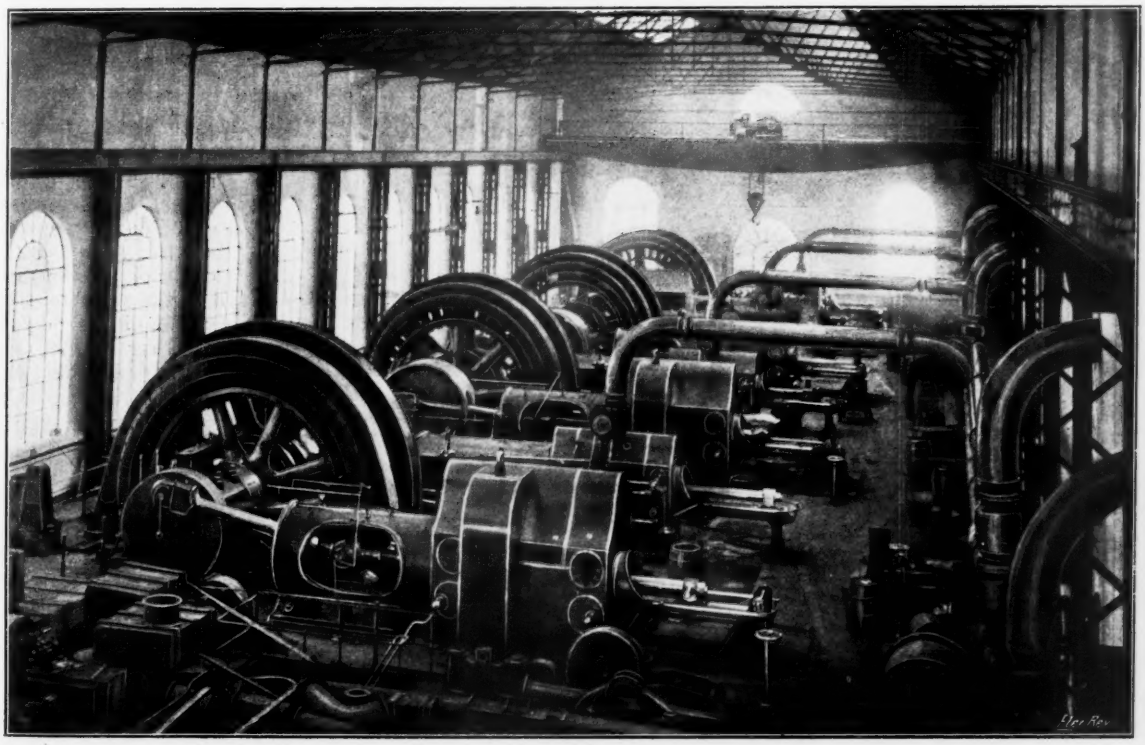
Glasgow Telephones.—Mr. Graham Murray, the Secretary for Scotland, has given his consent to the Glasgow Corporation Telephone Committee to borrow an additional £50,000 to provide the necessary funds for telephone developments.

LIVERPOOL—SOUTHPORT AND CROSSENS ELECTRIC RAILWAY.

(*Continued from page* 455.)

Power Station.

The equipment of the power house has been laid down on simple lines. The building is a plain and substantial one, erected by Messrs. Thomas Croft & Sons, of Preston, to designs prepared by Messrs. Dick, Kerr & Co., and upon elaborate foundations which were constructed by Messrs. Monk & Newell, of Bootle, under the immediate supervision of the engineers of the Lancashire & Yorkshire Railway Co. It consists of two divisions, the engine room being 280 ft. long × 65 ft. wide, and the boiler house, which is 50 ft. wide, having a similar length of 280 ft. The building consists of a steel roof in two bays, carried upon steel columns, all of which are independent of the brickwork, and have been made by Messrs. Head, Wrightson and Co., of Thornaby-on-Tees. The engine room is provided with overhead electric cranes capable of dealing with pieces of machinery up to 20 tons, built by Messrs. Jessop and Appleby, of Leicester.



General View of Engine Room.

There are installed four 1,500-kw. units, of which three will under normal conditions meet the demands. In addition, there is a fifth unit of 750 kw., which will form a useful link between the larger units, and thus permit considerable flexibility in obtaining a good load factor with high efficiency.

The four main engines are of the horizontal cross-compound type, the fifth engine being a vertical cross-compound. The horizontal engines have cylinders 32 in. and 64 in. in diameter, with 4 ft. 6 in. stroke, and run at 75 revolutions per minute. The normal load of each engine is 2,310 h.p., with a steam pressure of 160 lbs. per sq. in., but they are designed to give an overload of 20 per cent. The main engines, as well as the boilers, were supplied by Messrs. Yates & Thom as sub-contractors to Messrs. Dick, Kerr & Co., Ltd.

The cylinders of the main engines are of the built-up type, with separate ends and barrel, the valves being placed in the cylinder ends. The steam valves are worked by Messrs. Yates & Thom's well-known trip gear, the closing of the valves being accomplished by powerful vacuum dash-pots. The exhaust valves have a plain motion, derived, like the motion for the steam inlet valves, from eccentrics fixed on the crankshaft. Specially powerful and sensitive governors have been fitted to the engines; each governor is also fitted with a special safety stop arrangement, which will completely stop the engine in the event of its reaching a speed 10 per cent. above the ordinary working speed, and will also shut down the plant in the event of any failure of the governing gear.

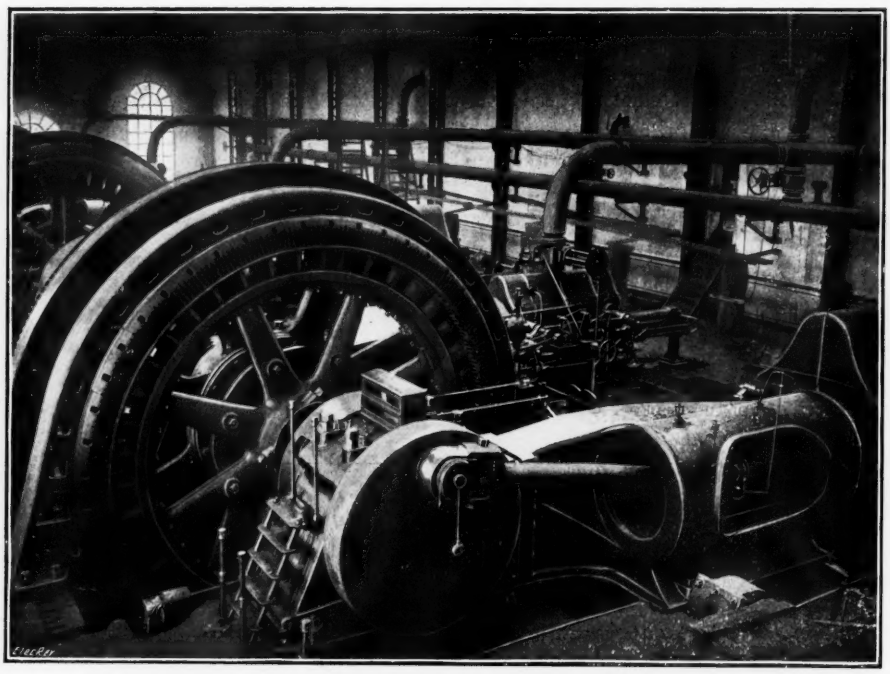
Each cylinder is bolted at the front end to a massive cast-iron bed frame of the Corliss trunk type, with bored guides for the piston rod crossheads, the outer or bayonet ends of these frames being bolted up to suitable facings cast on the crankshaft pedestals, which are large independent castings resting directly on the foundations. The frames bear upon the foundations throughout their entire length.

Each fly-wheel is 22 ft. in diameter, and is directly attached by strong bolts to the rotor.

The engines are solidly constructed, and of massive proportion, the weight of each bed frame being 14½ tons. Each crankshaft main bearing weighs about 11 tons, and the crankshaft 17 tons; the cranks weigh five tons each.

The pistons are of cast-iron fitted with Ramsbottom rings, the low-pressure pistons having also bands of white metal to improve their wearing properties.

The piston rods are made of Siemens-Martin steel, and



Dick, Kerr 1,500-kw. Alternator and Yates & Thom Engine.

are carried through the back ends of the cylinders, being made of a large size, so as to serve as a substantial support to the pistons.

The crossheads are made of wrought-iron fitted with gun-metal steps; the connecting rods are of wrought-iron.

The crankshaft is made of Siemens-Martin steel, and the crankshaft main bearings are of cast-iron lined with Babbitt's metal. A very complete system of lubrication is employed.

Each engine is fitted with a condensing apparatus, consisting of two Edwards air-pumps worked from the low pressure tail rod by means of links and levers. The condenser is of the jet type, having in connection with it a sluice valve and an automatic exhaust valve.

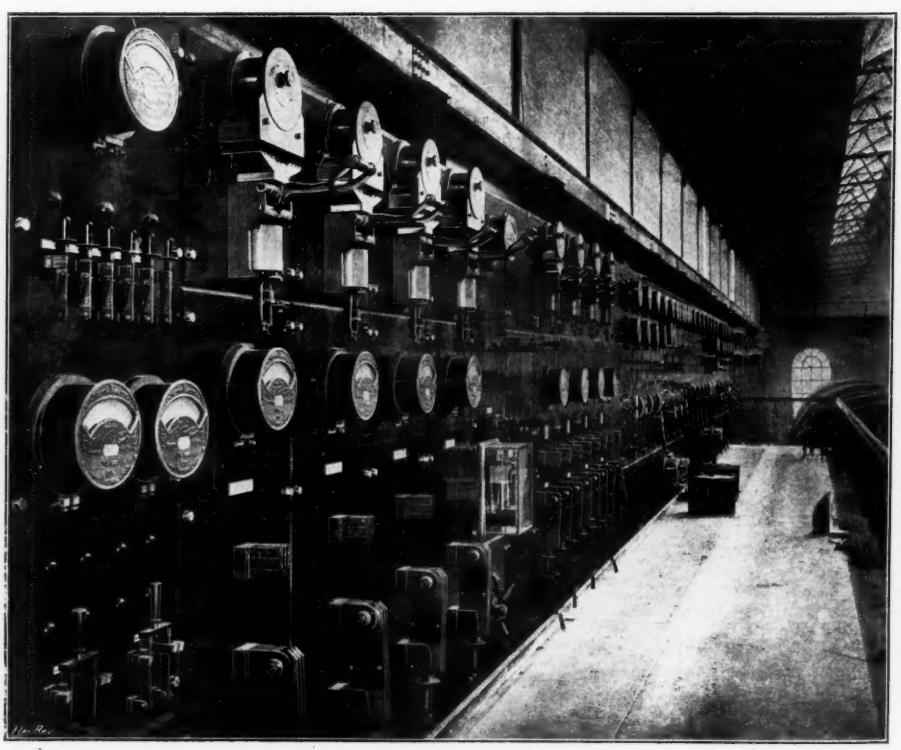
The vertical cross-compound engine has cylinders 23 in. and 46 in. in diameter, with 3 ft. 6 in. stroke, and will develop 1,180 H.P., when running at 94 revolutions per minute. The general construction of the engine is similar to that of the horizontal engines, the main difference being in the framework and staging. A similar arrangement of condensing apparatus has also been adopted, the air-pumps being worked by means of levers from the low pressure main crosshead. With each engine is also supplied a barring gear driven by a Dick, Kerr electric motor.

The alternators are three-phase, 25 cycles per second, the larger running at 75 r.p.m. and the smaller at 94 r.p.m., with a pressure of 7,500 volts. These machines, together with the remaining electrical plant, were made at the Preston Works of Messrs. Dick, Kerr and Co. Each rotor or magnet wheel is carried between the cranks, the armature ring or stator being erected on its own slide beds, concreted in and bolted down on the engine foundations.

The rotor of the 1,500 KW. generator carries 40 radial cast-steel poles of oval section, secured by tap bolts to the outside rim of two finished cast-steel rings of massive T section, carried by and driven from a central cast-iron spider by 16 axial bolts.

The pole tips are of laminated steel, with a central air space corresponding to grooves on the pole sides and the clearance between the rotor rings; they are dovetailed into the poles to keep the field coils in position. These are of bare copper strip, wound on edge. The outer surface of the coils is left bare, to aid the dissipation of heat, while the central ducts on the poles give ample ventilation to the iron.

The cast-iron spider is built in halves and clamped on the shaft by four heavy bolts. The magnet rings are also in



Main Switchboard.

halves, but staggered relative to each other and to the spider, and are shrunk together by double-headed keys.

The cast-iron slip rings are carried on either side of a cast-iron spider by axial bolts, insulated with ebonite. On each slip ring bear three carbon brushes.

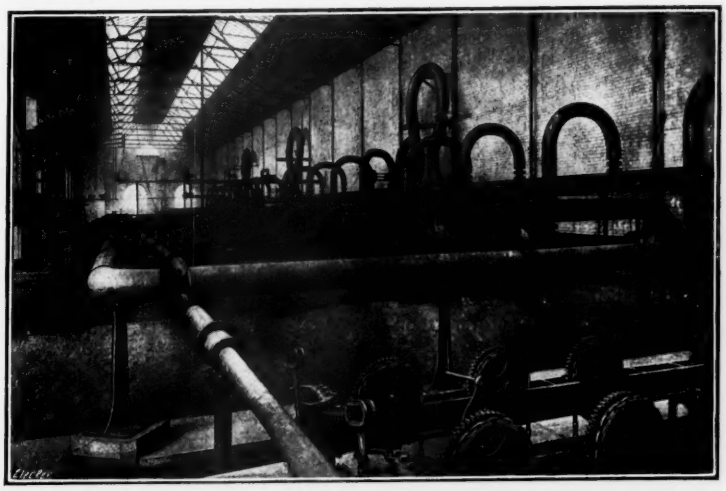
The weight of the magnet wheel complete is about 48,500 lbs., of which the poles account for 12,800 lbs. and the spools 6,350 lbs.

The stator consists of a cast-iron frame carrying the core discs on its inner periphery. The core segments are of annealed iron, punched in sections with their paper insulation. The sections break joint to equalise the reluctance, and are strung true on through bolts that clamp them up between a deep internal flange and a stiff cast-iron end ring built in sections. The complete stator weighs 75,800 lbs. Each coil is fully insulated, dried and tested to 15,000 volts before being inserted in the slots, the stator when completed being also adequately tested. Special ventilation ducts are provided, the rotating field forcing cool air through these ducts and out through apertures cored in the frame. The winding of each phase is distributed over two slots per pole. The connection is star with centre earthed.

The stator terminals consist of three high-pressure porcelain pots carried on a bracket at the bottom of the frame and enclosing the bare couplings. In each alternator provision is made for shifting the stator axially by ratchet jacks, to clear the rotor and give comfortable access to the windings.

The constructional features of the 750-KW. alternator are almost identical with those of the 1,500-KW. sets.

There are three direct current exciter sets, each consisting of a standard Dick-Kerr four-pole 100-KW. generator coupled to a Willans & Robinson high-speed engine, running at 318 r.p.m., the working voltage being 125. They also operate the station lights and ash conveyor and the barring motors. The general design of the machine is on the well-known Dick-Kerr lines.

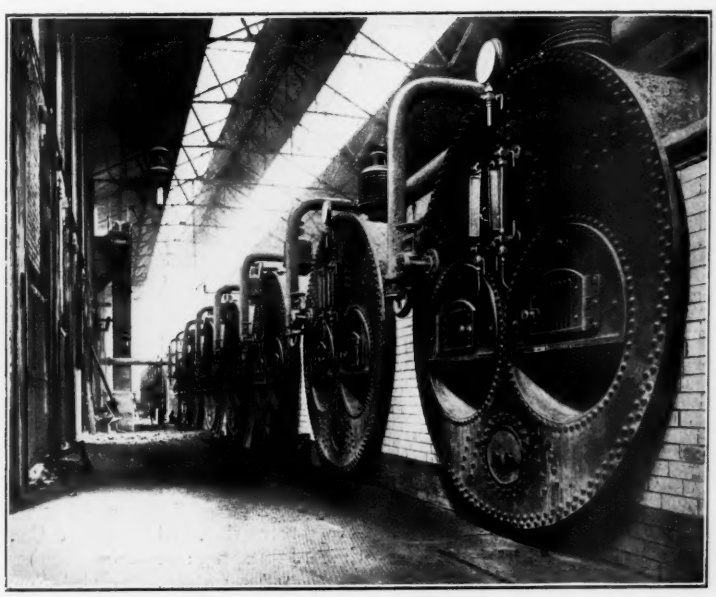


Steam and Feed Piping.

The main switchboard is erected on a gallery over a fireproof high-pressure chamber, and is built up of 33 2-ft. panels of enamelled slate. Starting from the right, there are swing brackets carrying two A.C. bus-bar voltmeters reading to 8,000 volts, synchronising voltmeter 0 to 16,000 volts, and rotary synchroniser with lamps; five main generator panels, one blank panel, one total station power panel, six high-pressure feeder panels for the distant sub-stations (Seaforth, Sandhills and Birkdale); three exciter panels, one sub-station total power received panel, four high-pressure sub-station transformer panels, one blank panel, four rotary converter direct current panels, one blank panel, one sub-station total power delivered panel, also comprising one sub-panel switch for starting rotary converter from D.C. 600-volt bus-bars; four sub-station feeder panels; and lastly, one station lighting and blower motors' starting panel, and swing bracket with rotary converter bus-bar voltmeter and paralleling voltmeter—all the sub-station gear being for the local sub-station at Formby.

The whole of the high-pressure switchgear, oil switches, instrument transformers and bus-bars are erected in a fireproof chamber, the dimensions of which are 79 ft. × 12 ft., and which is constructed of steel girders and concrete. Connection between the terminals of each stator and its oil switch is made by a three-core copper cable, paper-insulated and lead-covered. The rest of the high-pressure cables are single-core rubber-insulated, taped and braided; they were designed to pass a flash test of 25,000 volts between the conductors and each to earth. The solid copper rod high-

Dick, Kerr 200-kw. Transformer.



Yates & Thom Boilers.

pressure bus-bars are insulated in a similar manner, and reduced in section from alternators to local sub-station panels as power is tapped off. The bus-bars and individual leads are carried on corrugated porcelain pots, connection between oil switch and bus-bar being made through a high-pressure insulating or "hook switch." The wattmeters were supplied by the Stanley Wattmeter Co. The voltmeter transformers were built by Messrs. Dick, Kerr & Co., Ltd., the voltmeters, ammeters, and current transformers by Messrs. Elliott Bros., who also supplied the panels for the main board, the switches and circuit breakers being made at the Preston Works.

The total A.C. energy generated, before passing to the sub-station feeders, is recorded by an integrating wattmeter. Connection to each triplet of transformers in the sub-station is made through a hook switch, oil switch and three cast-iron tail-end glands, bushed with corrugated porcelain bobbins, piercing the front wall of the chamber. Each transformer is single-phase, split-phase, and has two independent secondaries, the six of the triplet being grouped in double mesh to afford six phases for operating the rotary converters. Connection between the grouped secondaries and the six rotary slip-rings is made through a pair of three-blade switches carried on a stand, on which is also placed the equaliser switch for the series field.

The chief feature of the alternating board is that the high-pressure current is confined to the pit below the board, this being effected by the long-arm oil switches which are used throughout the system.

The rotor field rheostats are of massive construction, and consist of cast-iron grids, insulated with hard micanite, and assembled in frames forming layers in a vertical stack, which is open at top and bottom for thorough ventilation.

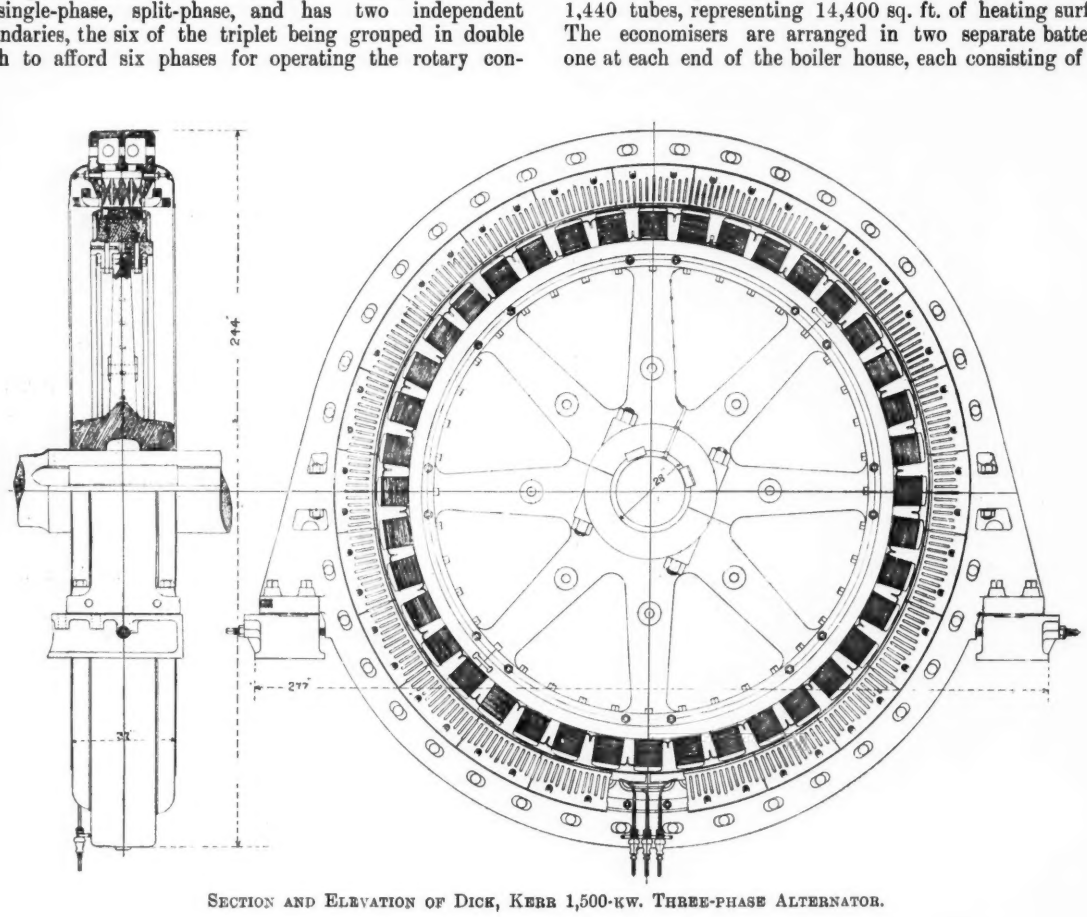
There are 16 boilers made by Messrs. Yates & Thom, of the Lancashire type; each boiler is 32 ft. long × 8 ft. 6 in. diameter, with two flues each 3 ft. 5 in. diameter, and is constructed for a working pressure of 160 lbs. per sq. in. The boilers are equipped with a full set of fittings and mountings made by the same firm, and are hand-fired. They are arranged in two batteries of eight each, in one row.

In each of the down-take flues at the back end of the boilers is fitted a superheater of the Galloway type. The feed pumps were supplied by Messrs. Mather & Platt, Ltd.

The fans for the induced draught work are two in number, each capable of furnishing sufficient air for the consumption of 10,000 lbs. of coal per hour, with a temperature of the flue gases, after passing through the economisers, of about 400° F., and this at a normal speed of 175 r.p.m. The fans are of the three-quarter housing over-hung blast-wheel type, directly connected to horizontal side-crank engines. The blast-wheels are carried on steel shafts 5 in. in diameter, and supported by self-oiling water-cooled bearings 27 in. long.

The products of combustion, after passing through the economisers, enter the fans at a temperature of about 400° F., and are discharged through underground brick ducts to the base of the chimney located just outside the building. This chimney has a height of 60 ft. The whole of the induced draft apparatus was supplied by the Buffalo Forge Co.

The economisers working in conjunction with the boilers were made by Messrs. Green & Son, Ltd., and comprise 1,440 tubes, representing 14,400 sq. ft. of heating surface. The economisers are arranged in two separate batteries, one at each end of the boiler house, each consisting of 720 tubes. These are again sub-divided into two separate apparatus of 360 tubes, which can be worked together or independently as occasion requires. The scrapers are actuated by a double set of gearing driven by a direct-geared electric motor. The total water capacity of the economisers is some 9,000 gallons.



Section and Elevation of Dick, Kerr 1,500-kw. Three-phase Alternator.

The whole of the steam, feed, exhaust and injection main and auxiliary piping was fitted and prepared by Messrs. Dick, Kerr & Co., at their Kilmarnock works. The feed ring (6 in. diameter) runs the whole length of the boilers, branches to each boiler being taken through check valves. The ring is supplied from pumps in triplicate. The feed water can be passed either through the economisers or direct to the boilers, by a duplicate system.

The main steam piping, which is 12 in. in diameter, is a combination of the ring and bye-pass systems. The steam is taken from the boilers, passed through superheaters, and then into the main ring or direct through a bye-pass to the engines. The steam pipes are entirely on the duplicate system, and are of steel.

The exhaust pipes from the main engines are 24 in. in diameter, and are connected direct to jet condensers. The

whole of the exhaust piping from the exciter sets, fan engines and boiler feed-pumps is connected to an auxiliary surface condenser. The blow-off and main drain are connected to a common blow down tank.

The whole of the boilers, piping and cylinders, were covered by Messrs. Lonsdale Bros., Ltd., of Blackburn, with their patent plastic cork non-conducting cement.

(To be continued.)

TELEGRAPH AND TELEPHONE NOTES.

Imports of Foreign Telegraph Cables and Apparatus.—The value of the foreign telegraph cables and apparatus imported into this country during February last amounted to only £2,985, bringing the total for the first two months of the year to only £6,734, as against £17,036 in the corresponding two months of 1903.

The Post Office and the Telephone System.—In the House of Commons on Tuesday, Lord Stanley submitted, in Committee, as a preliminary to legislation, a resolution sanctioning the allocation of £3,000,000 for the extension and development of the Post Office telephone service. He reminded the Committee (according to the *Times* summary) that £4,300,000 had been voted for this purpose in past years, and he said that this sum was now very nearly exhausted. The money for which he was asking was wanted for the extension of trunk lines and for the provision of exchanges. £1,300,000 would be set aside for trunk lines; £1,500,000 for London exchanges; and £200,000 for provincial exchanges. He gave a short account of the work accomplished by the department, mentioning that the number of conversations carried on through the telephone in one year was 12,895,883. There was sufficient plant in London for the needs of 40,000 subscribers. The actual number of subscribers was 15,299, and it was expected to increase largely. There were in the metropolis 1,094 miles of underground pipes and 110,128 miles of wire. At the end of 1899 there were 1,259 Post Office telephones in the provinces; now there were 5,000. The receipts were increasing rapidly. In the Central London exchange in 13 months they amounted to £61,000. He believed that it would not be long before the telephone service became a paying concern, and so he was not asking the Committee to vote money for an unremunerative object. The department was not contemplating competition with the National Telephone Co. in areas which that company supplied. As the Committee knew, the department could give notice before the end of this year of its intention to purchase the undertaking of the company, and it was empowered to proceed by arbitration if an agreement could not be come to. As an arbitration would be very expensive, he favoured the plan of amicable agreement. Negotiations, he informed the Committee, were being carried on at the present moment. No agreement would be held to be binding until it had been ratified by Parliament. He thought he should be able to act on the suggestion which had been made, that a Select Committee should be appointed to consider the agreement. He also stated that he should be ready to help municipalities desiring to have their own telephones The resolution was agreed to.

On Wednesday Lord Stanley modified his statement, and said that *pourparlers* were going on in regard to the purchase, but the stage of *negotiation* had not yet been reached.

Presentation to Mr. J. F. W. Hooper.—An interesting impromptu ceremony took place on March 16th at the works of Hooper's Telegraph and India-rubber Works, Ltd., at Millwall Docks, when Mr. Hooper, the works manager, grandson of the late Mr. William Hooper, was presented by the employés of the firm with a very handsome silver epergne and two fruit stands to match, together with a large framed photograph of the foremen and leading hands, several of whom have been in the service of the company for over 30 years. The occasion was brought about by the announcement of the marriage of Mr. Hooper to Alice Dora, daughter of Mr. and Mrs. Rathbone, of Bramleigh, Leigham Court Road, Streatham, on April 14th. Mr. and Mrs. John P. Hooper and the bride elect had been asked to be present, as the meeting was attended by all employed at the works to show their good feeling and esteem for the family.

The presentation was made by the foremen, Messrs. F. Stokes and J. Wilmot, after a capital congratulatory speech made by Mr. Skinner, of the electrical department, expressing the sentiments of the donors, from which we extract the following passages:—

"As chairman of committee of presentation I have to give expression to the thoughts, reasons and motives that have actuated us, the employés of Hooper's Telegraph Works, in all that is connected with this gathering. Our one aim and object is to do honour to you, Mr. Fred, and to show also that the kind, practical, generous and sympathetic manner as a gentleman, while ever retaining the dignity of your position, that you have shown towards us, have stirred in us a sense of gratitude, which finds its expression in our little offering.

"Those of us who were here when you first came to works, will remember the mingled feelings of consternation and speculation that moved us as we wondered what the end would be. Not that we doubted for a moment that the generous dealing of your father would be continued towards us, but we well knew that the introduction of young blood into a firm like ours, is often the forerunner of radical changes, not only in things pertaining to works, but also to persons employed there.

"But as the time rolled on, instead of having cause to fear, we have had more work, and as a consequence, more wages, and a general betterment all round. And this at least we have learned; the prosperity of our employers, must of necessity be the prosperity of their employés, so that we, by working hand in hand to turn out good and quick work, participate in the profitable returns.

"It will, I am sure, be a sense of gratification to you to know that the hands are unanimous as to this presentation, that to make it worthy of the occasion, it has been one round of special effort.

"It is our expression of respect and esteem for you, Mr. Fred; we want you to know it is our earnest desire, that the practical sympathy and generous dealing may still be continued to us, so that if we may look back and remember the readiness you have shown in assisting us, whether it has been for a sick club, a suffering employé, a cricket club or a Bible reading, we may know that the same interest will still be ours.

"I have now much pleasure in calling on Messrs. Stokes and Wilmot, to uncover and present to you our little gift, again asking you to believe that it is not merely a gift through policy, or of necessity, but an intelligent desire to express to you our confidence in you, and our respect for you, in your own personality, and as the representative of your father and a jolly good firm."

Handsome bouquets of flowers were presented by the forewomen to the lady visitors.

Mr. Hooper, in returning his thanks for such a beautiful present, referred, in words most happily chosen, to the mutual confidence of those present, and expressed good hopes for the continued prosperity of the firm.

As an interesting fact, it may be mentioned that the firm are about to ship for the Great Northern Telegraph Co., on their new repairing steamer, *Pacific*, which has been built for work in the China seas, and was expected to arrive in Millwall Docks at the end of March, some 90 miles of cable, containing core manufactured 35 years ago and re-sheathed. The tests of this cable show little, if any, depreciation since it was first manufactured; now giving 3,500 megohms D.B. first minute at 75° F., and 6,500 megohms second minute; as compared with 4,000 megohms first minute when first manufactured in 1869-70, the core being made up of 300 lbs. copper strand, insulated with 200 lbs. of Hooper's india-rubber insulation.

Telegraphic Interruptions and Repairs:—

	Cables.	Interrupted.	Repaired.
Dominica-Martinique		May 5, 1902	
St. Lucia-Martinique		May 7, 1902	
Trinidad-Demerara No. 1		Aug. 27, 1901	
Cayenne-Pinheiro		Aug. 18, 1902	
New York-Hayti		April 18, 1903	
Anjer-Kaljanda		Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran		Oct. 22, 1902	
Tourane-Amoy		Nov. 10, 1903	
Tarifa-Tangier		Jan. 18, 1904	
St. Jacques-Haiphong		March 7, 1904	
Closed { Nagasaki-Vladivostock		Feb. 15, 1904	
Closed { Port Arthur-Chefu		Feb. 18, 1904	
	Landlines.		
Seoul-Massampo		Feb. 13, 1904	
Seoul-Gensan		Feb. 13, 1904	
Anju-Ping-Yang		Feb. 25, 1904	
Ninguta-Vladivostock		March 2, 1904	

Wireless Telegraphy.—In the House of Commons the other day, Mr. Gerald Balfour, replying to Mr. Henniker Heaton, stated that arrangements were being made by the Trinity House for the fitting up of wireless telegraphic apparatus on certain of their lightships on the east coast by way of experiment. The matter was being pushed forward, and an agreement for the use of patent rights has been drawn up, and was being considered by the various departments interested. Permission had been granted to Lloyd's to establish a wireless telegraphic station at the Fastnet. He was unable to say at present to what extent the system would be applied to other light stations, many of which are already connected by cable with the shore.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 31st. Two water-tube boilers and accessories. See "Official Notices" March 11th.

Acton.—April 12th. The U.D.C. invites tenders for two 200-KW. motor-generators, switchboard, cables, arc lamps, accumulators, and crane. See "Official Notices" to-day.

Barnes.—April 12th. Batteries, boosters and switchgear for the electricity works. See "Official Notices" to-day.

Handsworth.—March 30th. The U.D.C. invites tenders for contract No. 1 (Holyhead Road)—permanent way, paving and road work and overhead equipment. See "Official Notices" March 11th.

Burton-upon-Trent.—April 5th. One 500-KW. steam generating set and condensing plant. See "Official Notices" to-day.

Chili.—June 28th. Electric lighting of the city of Punta Arenas (Straits of Magellan). See this column for February 19th.

Cuba.—April 15th. Tenders are being invited until April 15th by the General Direction of Communications in Havana, for the establishment and working of a telephone exchange in the town Guantanamo. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Communicaciones, Havana.

Dartford.—March 26th. The U.D.C. invites offers for constructing and working light electric railways. See "Official Notices" March 18th.

Dundee. — March 26th. Electricity meters. See "Official Notices" March 18th.

Edinburgh.—April 4th. Electricity meters for the Corporation. See "Official Notices" March 18th.

Edinburgh. — April 23rd. Switchboard extension, piping. See "Official Notices" to-day.

Foot's Cray.—The Council invites offers for the purchase or working of its prov. order. See "Official Notices" to-day.

France.—March 30th. The French Ministry of Post and Telegraphs is inviting tenders until the 30th inst. for the supply of 200 tons of copper wire, and 80 tons of bimetallic wire. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Lancaster.—April 14th. Permanent way, overhead trolley and other tramway work. See "Official Notices" March 18th.

Manchester.—April 7th. Synchronous motor-generators for sub-stations; superheaters for Dickinson Street. See "Official Notices" March 18th.

May-Oatway Installations.—Tenders for installations on this system at Belfast and Dundee. See "Official Notices" to-day.

Melbourne.—May 13th. One 750-KW. direct-current steam generator. See "Official Notices" March 18th.

Natal.—May 9th. Electric telpherage system for Bonded Warehouse. See "Official Notices" March 18th.

Partick.—April 12th. One 500-KW. steam dynamo, 75-KW. balancer, and switchboard extensions. See "Official Notices" to-day.

Poplar.—March 26th. Three-phase motor-generators, switchboards and cranes. See "Official Notices" March 18th.

Reading.—April 2nd. Six double-deck bogie cars, and one water cart. See "Official Notices" March 18th.

St. Anne's.—March 26th. Condensing plant and cooling tower. See "Official Notices" March 11th.

Spain.—April 2nd. The Spanish Post and Telegraph Authorities in Madrid are inviting tenders for a telephone exchange with sub-exchanges. See this column for March 18th.

Stockport.—March 30th. One 500-KW. steam generator. See "Official Notices" March 11th.

Sunderland.—March 31st. India-rubber cables for a year. See "Official Notices" March 4th.

St. Albans.—April 6th. Electric wiring of Napsby Asylum, for about 2,500 points. See "Official Notices" to-day.

Swindon.—March 31st. Water softener, 60-KW. motor-generator, switchgear, lamps, cables, oils and meters. See "Official Notices" March 11th.

Tynemouth.—April 22nd. Meters, indicators, and motor hiring for the Corporation. See two "Official Notices" in to-day's issue.

Westminster.—April 18th. High and low-pressure switchboards for the Westminster Electric Supply Corporation. See "Official Notices" March 18th.

CLOSED.

Battersea. — The B.C. has accepted the following tenders:—

Two water-tube boilers, one fitted with hand-fired furnace, Messrs. Babcock and Wilcox, Ltd., £2,300.
Electric pumps and pipes in connection with the extension plant, Messrs. Mather & Platt, Ltd., £825.
Spare armature for the steam turbine dynamo, Messrs. Parsons & Co., £700.
Carbons for arc lamps for 12 months, Messrs. De Grelle Houdret & Co.
Oils and engine room stores for 12 months, Messrs. Willcox & Co., Ltd.
Meters for 12 months (ampere-hour), Messrs. Chamberlain & Hookham; (watt-hour), the British Thomson-Houston Co., Ltd.

Also the following:—

Messrs. Mackenzie Bros., arc lamp pillars and brackets, £172 10s.
Gilbert Arc Lamp Co., Ltd., arc lamps with hoisting and lowering gear, £187.
Simplified Underground Conductor Co., Ltd., telephones for switch pillars.
Mr. G. M. Marchant, valves.
Messrs. Venner & Co., special meter.

Camberwell.—The B.C. has received the following tenders for an engine and dynamo for the lighting of the Baths:—

Royce, Ltd. (incomplete)	£317	British Westinghouse Co.	£490
Woods & Co.	335	Bakewell & Co.	530
Durtnall & Pries	388	,, ,,	549
Davey, Paxman & Co. (incomplete)	388	Brush Elec. Eng. Co.	550
Johnson & Phillips	340	Sunderland Forge Co.	560
Alliance Electrical Co. (*accepted*)	355	Mossop & Co.	572
R. Murray (incomplete)	375	Goddard, Massey & Warner	599
T. S. Anderson	470	Mather & Platt	634
Witting, Eborall & Co.	485	Geipel & Lange	645

The successful tenderers are allowing £80 for the old engine, whereas the firms quoting lower prices only allow £30.

Canada.—A contract for the motor-cars and power-house equipment of the Canadian Electric Traction Co. for the London, St. Thomas and Port Stanley Railway, comprising 1,000-H.P. power-station equipment, three-phase transformers, &c., 10 250-H.P. three-phase motor-cars, each to seat 50 passengers, speed 30 miles an hour, has been given to Messrs. Bruce Peebles & Co., Ltd. The whole of the plant will be on the Ganz system, and will be built in Edinburgh. The contract price is £42,250. The matter receives mention in our "Tramway and Railway Notes" to-day.

Croydon.—The Board of Guardians has accepted the tenders of the Edison & Swan Co. for the supply of electrical fittings for Croydon Union Workhouse for the year ending Lady Day, 1905; also that of Messrs. Pryke & Palmer for the supply of engineers' goods for the same period.
The Corporation has accepted the tender of the Callender's Cable Co. for cable for the ensuing year, and also the tender of Messrs. Babcock & Wilcox for pipe work.

Glasgow.—The Committee has accepted an offer by the Electrical Co., Ltd., for providing and erecting three sets of balancers, to be used in connection with the motor-generators to be supplied by that firm, at a price of £100 for each set.

Hammersmith.—The B.C. on Wednesday accepted the following tenders for annual supplies:—

Carbons, the General Electric Co.
House service boxes, Henley's Telegraph Works Co., small size, 11s. 6d., large size, 17s. 6d.
Meter boxes, Henley's Telegraph Works Co., 25 amp. 19s. 6d., 50 amp. £1 4s.
Meters, British Thomson-Houston Co., 5 amp. £2 5s.; 10 amp. £2 7s. 6d.; 15 amp. £2 10s.; 20 amp., 25 amp., 40 amp. £2 12s.; 50 amp. £3 15s.

Harwich.—The Westminster Engineering Co., Ltd., has received from the Admiralty the contract for the electric light and power installation at the Royal Naval Hospital, Shotley Point, Harwich. Three 50-H.P. oil engines of Messrs. Gardner's make form part of the contract.

Lyons and Paris.—We understand that the Electricité et Hydraulique of Charleroi, have secured an order for 40 electrical equipments for the Lyons tramways, comprising motors of 27-H.P. each. An order has also been placed with this firm for 16 motors, each of 125-H.P. for traction purposes on the Metropolitan Railway of Paris, these being controlled on the multiple unit system.

Plymouth.—The Admiralty has placed a large order for the supply of electricial apparatus and material for the new Naval Hospital, Plymouth, with Messrs. Veritys, Ltd., London.

Poplar.—The Electricity Committee has received the following tenders for the supply of two turbo-generators and condensing plant:—

Bruce Peebles & Co. (recommended) (Parsons turbine)	£13,351
,, alternative (Willans)	10,911
Mather & Platt (Parsons)	14,890
,, alternative (Willans)	14,068
Parsons & Co. (Parsons)	14,310
Richardson, Westgarth & Co. (Westgarth)	13,150
Willans & Robinson (Willans)	12,074

The electrical engineer reported that the cost reduced to equivalent steam consumption at full load of 16·5 lbs. per unit worked out thus:—

Bruce Peebles & Co.	£13,351
,, alternative	12,741
Mather & Platt	14,890
,, alternative	15,928
Parsons & Co.	14,310
Richardson, Westgarth & Co.	14,065
Willans & Robinson	13,904

Preston.—The Corporation has accepted the tender of the St. Helens Cable Co., Ltd., for the supply and laying of "Dialite" feeder cables for their tramway extensions.

Radcliffe.—The U.D.C. has accepted the tender of Messrs. J. D. Firth & Sons, of Manchester, for the supply of station lighting and testing instruments.

Walthamstow.—The U.D.C. has accepted the tender of the General Electric Co., Ltd., for the supply of electricians' materials for the ensuing 12 months.

West Ham.—The Corporation has received the following tenders for the supply of 11 motors, &c., for tramcar shed tool equipment:—

Witting, Eborall & Co., Ltd. (accepted)	£474 17 0
George Hatch, Ltd.	540 0 0
Buck & Hickman, Ltd.	554 0 0
,, ,,	568 17 6

The Corporation has accepted an offer of the British Thomson-Houston Co., Ltd., to supply 200 open type arc lamps at £5 per lamp with iron cases, or £5 5s. with copper cases. They have also placed an order with Messrs. Kelvin & White, Ltd., for testing instruments for the laboratory at the new generating station at £209.

Walthamstow.—Three additional 250-B.H.P. producer gas engines have been ordered from the British Westinghouse Co. for station extensions here in connection with the tramway supply. See "Business Notices" to-day.

FORTHCOMING EVENTS.

Friday, March 25th.—At 5 p.m. Physical Society. "Note on the Measurement of Small Inductances and Capacities, and on a Standard of Small Inductance," and "A Hot-wire Ammeter for Measuring very Small Alternating Currents," by Prof. J. A. Fleming; "The Energy of Secondary Röntgen Radiation," by Mr. C. G. Barkla.

At 7.30 p.m.—Institution of Electrical Engineers (Manchester Students). "Photometric Testing," by Mr. D. L. Sands.

At 7.30 p.m.—North-East Coast Institution of Engineers and Shipbuilders. Meeting at Newcastle. Discussion to be resumed on Mr. B. C. Laws's paper on "Technical Education."

At 8 p.m. Electro-Harmonic Society, Last Smoking Concert of the season. See "Notes."

At 8 p.m. Institution of Civil Engineers (Students). "The Relative Advantages of Continuous and Alternating Current for Traction Purposes," by Mr. J. M. Kennedy.

At 9 p.m. Royal Institution. "Liquid Hydrogen Calorimetry," by Prof. Dewar.

Saturday, March 26th.—At 3 p.m. Royal Institution. "The Life and Work of Stokes," by Lord Rayleigh. (Lecture VI.)

At 7.30 p.m. The Glasgow Technical College Scientific Society. Annual general meeting.

NOTES.

Our Issue for Next Week.—It is necessary that the issue of the ELECTRICAL REVIEW for April 1st (Good Friday) shall appear two days earlier than usual—Wednesday morning, March 30th. We shall be glad if our friends will take note of the following arrangements:—

Editorial Pages.—Correspondence must be in our hands by 10 a.m. on Monday next, March 28th. Reports, notes, and all small editorial matter by 5 p.m. on the same day.

Advertisement Pages.—New copy and alterations to existing displayed advertisements by to-morrow, Saturday morning, March 26th; Official Notices and small prepaid advertisements can be received up to the morning of Tuesday, March 29th, the day before publication.

American Electro-Chemical Society.—The annual meeting is to be held at Washington on April 7th, 8th and 9th. The following are the titles of some of the papers arranged for:—

"The Composition and Resolution of Voltages," by Dr. J. W. Richards.
"Notes on the Industrial Electrolysis of Water," by Mr. W. S. Landis.
"Standard Cells," by Dr. F. A. Wolff.
"Electric Smelting Experiments for the Manufacture of Ferro-Nickel from Pyrrhotite," by M. Ernst A. Sjostedt.
"A Contribution to the Study of the Electric Arc," by Dr. Wm. S. Weedon.
"The Energy of Ions," by Dr. L. A. Parsons.
"Some Experiences in Copper Precipitation," by Hermann Poole.
"A New Electrolytic Separation of Gold and Silver," by Hermann Poole.
"The Preparation of Materials for Clark and Weston Standard Cell," by Dr. H. S. Carhart and Dr. G. A. Hulett.
"The Determination of 'H,' at Annisquam, Mass., by Tangent Galvanometer," by Barry MacNutt.
"The Economic Balance in Electrolytic Copper Refining," by Lawrence Addicks.
"Single Potentials of the Halogen Elements," by W. R. Mott.
"Observations on the Preparation of Electrolytic White Lead," by C. F. Carrier, Jr., A.C.
"Electrolytic Iron," by C. F. Burgess and Carl Hambuechen.
"A Relative Decimal Index for Electro-Chemical Interests," by Adolph L. Voege.

I.E.E. (Glasgow Section).—A smoking concert of this section was held at the Grand Hotel, Charing Cross, Glasgow, on Saturday last, March 19th, under the presidency of Mr. W. A. Chamen.

Gas Failure at Stretford.—A fire at the Stretford Gas Co.'s works a few days ago plunged a large district (containing 70,000 to 80,000 people) into darkness. The company's district is a very wide one, including Stretford, Chorlton-cum-Hardy, Sale, Brooklands, Urmston, Flixton, Ashton-on-Mersey, and Davyhulme. This area is 5 or 6 miles across, both from north to south and from east to west. Of the entire district, only one portion, Old Trafford, escaped, its supply being received from a main in the Thames Street side of the works, opposite to that on which the fire occurred. With the exception of that part of the Chester Road which forms the main street of Stretford, and which is lighted by electric arc lamps, every road and street was plunged in gloom. The area is largely a residential one, and the majority of the houses are dependent upon gas for their illumination, and, in many cases, also for heating and cooking facilities. We understand that the residents of Chorlton-cum-Hardy and Didsbury were fortunate enough to have the Manchester Corporation electricity mains at their doors, and hence those who had been wise enough to avail themselves of this supply did not suffer any inconvenience.

Madras College of Engineering.—An Indian contemporary says that the Government approves of the proposal to provide a new building for the workshops and the laboratories—mechanical, electrical and chemical—required for the College of Engineering, Madras.

The British Electrical Superannuation Fund.—The annual general meeting of the members was held at Donington House, Norfolk Street, on Wednesday, March 16th. Mr. C. G. Tegetmeier presiding in the absence, through indisposition, of Sir Ernest Spencer, M.P. In the course of his remarks, the chairman said that during the past year the fund had made satisfactory progress. During the year 12 new contributing companies had joined the fund, the most important one being the City of Birmingham Tramways Co. The other companies were mostly small, but their staffs would probably develop. The number of members of the fund at the end of the year was 183, being a net increase of 38, 64 new members having joined, and 26 having left the fund on retirement from the service of contributing companies. The expectation of a larger measure of support from companies outside the immediate circle of the British Electric Traction Co.'s organisation, had not so far been realised, and the reason seemed to be that the advantages which the fund offered were not sufficiently widely known among those who might be expected to take advantage of the benefits offered. The fund was at present only in its infancy, and when the advantages it offered became more widely known they would be more widely appreciated, and other companies would be following the example of the City of London Electric Lighting Co. who, after full examination of the details of the fund and the scheme, had given it their hearty support. The total amount of contributions from members who were on the fund on December 31st, was £3,904 18s. 7d. To meet the liabilities immediate and contingent in respect of these contributions, the fund had assets totalling £7,885, the difference being, of course, mainly at least explained by the amounts contributed by a company in respect of members who were still on the fund, and members who have retired from the fund. Withdrawals had been rather considerable during the year, but this had been owing to some exceptional circumstances, and it was not likely that the same rate of withdrawals would be continuous. The expenses of management are practically the same as last year, £178. The adoption of the report was seconded by Mr. J. S. Raworth, and carried unanimously.

The McMillan Memorial Fund.—In our issue of March 11th we were able to announce that the receipts for this fund up to that date had amounted to well over £900. We have now received a second official list showing the further subscriptions which have been received, the amount from the several classes of membership being £151; and from outside sources £38. The total so far is, therefore, in the neighbourhood of £1,100.

Electro-Harmonic Society.—The last E.-M. smoking concert of the season is to be held to-night, 25th inst. (Mr. W. M. Mordey presiding), at the King's Hall, Holborn Restaurant. The programme includes songs by Mr. Wm. Maxwell and Mr. Wm. Forington; the instrumental music will consist of cornet solos by Mr. Arthur Smith, and selections by the orchestra. Humorous sketches are to be given by Mr. Astley Weaver, recitations by Mr. Alexander Watson, and a ventriloquial sketch, &c., by Mr. Frederick Chester.

Institution of Electrical Engineers (Leeds).—The annual general meeting was held last evening at the Yorkshire College. A discussion on "Power Schemes—Projected and in Operation" was opened by Mr. W. B. Woodhouse and Mr. W. Emmott.

Punkah-Pulling in Punjab.—The *Indian Municipal Journal* says that the Indian Government has sanctioned the appointment, for a period not exceeding 12 months, on a salary of Rs. 700 per mensem, of an electrical engineer for the works connected with the electric lighting and mechanical punkah-pulling schemes in the Punjab Command. The electrical engineer will be employed in the first instance at Mian Mir.

Junior Institution of Engineers.—Last Saturday this Institution held its conversazione at the Westminster Palace Hotel. Mr. Fletcher Moulton, K.C., M.P., president, and Mrs. Moulton, with Mr. Samuel Cutler, chairman, and Mrs. Cutler, received the guests in the Victoria Hall. In the Albert Hall Mr. Alexander Siemens gave a "lecturette" on the Berlin Overhead Railway, "illustrated with a number of limelight pictures. Mr. Siemens repeated his discourse in the course of the evening.

Car Driving Prosecution.—At Southwark, F. G. Loates, the driver of a London County Council electric car, was summoned for furious driving. The police evidence showed that a woman had been injured by the defendant, and that the defendant's car passed a constable in Waterloo Road, travelling at the rate of 14 or 16 miles an hour. Defendant said that, owing to the rails being worn and greasy, he could not get his brake to act. One of the passengers said the defendant had been making up for lost time. The limit of speed for the cars at this place was eight miles an hour. Mr. Nairn, chief clerk, remarked that under Section 27 of the Hackney Carriage Act the magistrate had power to award the injured woman compensation up to £10. The driver then gave evidence that the actual speed was eight miles an hour; and Lane, the conductor, stated that it was "about eight miles, not much more."—Mr. Paul Taylor said it was most reckless driving. The defendant would be fined £3, the *maximum* penalty, and he would order the L.C.C., as owners of the car, to pay £8 compensation into Court for the woman. If another charge of this kind were brought before him the driver would be sent to prison.

Appointments Vacant.—Corporation electrical engineer for Chester at £300, rising to £500; switchboard attendant for Farnworth (£1); tramways manager for Rochdale (£300); engineering clerk of works for the Middlesex County Council, for Napsbury Asylum.

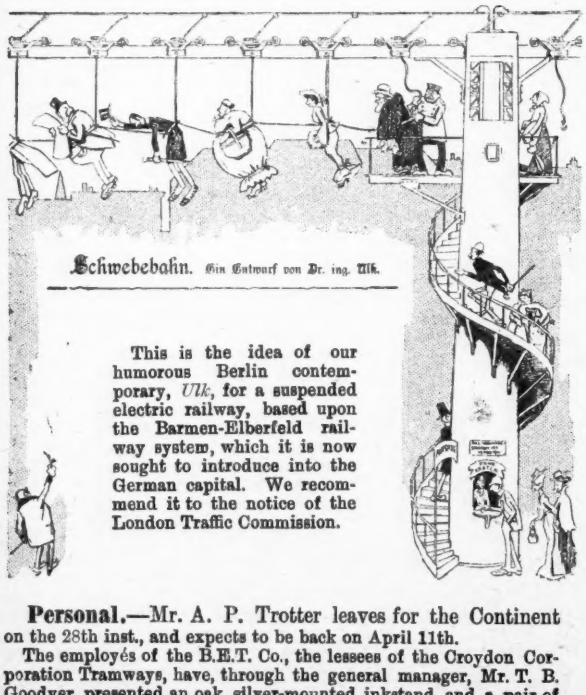
Association of Engineers-in-Charge Dinner.—The ninth annual dinner of this society was held at the Abercorn Rooms, Liverpool Street, on Saturday last. Sir R. M. Hensley, chairman of the Metropolitan Asylums Board, presided, and there was a large attendance.

After the loyal toasts, the chairman proposed "The Association," and remarked on the large addition to the membership last year. Eulogising "work" as a noble aim, he alluded to the improper methods of certain trade societies, and said that true liberty was the liberty to do right. The engineer of to-day required a vastly greater knowledge and skill than formerly, and incurred far more responsibility. His experience of 20 years showed that the officials of poor law institutions possessed a high standard of morality, though they were subject to severe temptations, the chief of which were drink, betting, and secret commissions.

Mr. W. T. Hatch, vice-president, in reply, pointed out the importance of common-sense to an engineer-in-charge; the Association had been formed to develop this talent, and individual members had, to his knowledge, derived great benefit from the papers and discussions.

Mr. W. C. C. Smith (president) proposed "The Chairman of the Evening," who briefly responded. Toasting "Our Authorities," Mr. C. A. Clarke (chairman of the Association) remarked on the small salaries to engineers allowed by the L.G.B. Capt. C. W. Andrew, of Lambeth Borough Council, and Mr. Edward White, of the L.C.C. and other institutions, responded, the latter agreeing as to the parsimony of the L.G.B., but stating that he believed that the Board was now more indulgent. Toasts to "The Visitors," and "The Press" followed. A concert was performed between the speeches, under the direction of Mr. G. Hardy, and the entertainment was in every way highly successful.

The Postmaster-General v. Croydon U.D.C.—At the Croydon County Court on Tuesday, Sir Robert Hunter, on behalf of the Postmaster-General, applied to Judge The Hon. Arthur Russell for his Honour's consent to the placing of telegraph poles in certain thoroughfares within the jurisdiction of the Croydon Rural District Council, that body having refused its consent. In some cases the Council demanded that the wires should be laid underground, and in others it demanded that the wires should be affixed to the posts already erected by the National Telephone Co. In other cases the Council demanded a different sort of pole from the usual creosoted pole adopted by the Post Office, which, Sir Robert Hunter raised a smile by stating, harmonised with the trees and the general rural aspect of the neighbourhood. After a prolonged hearing his Honour decided that in the higher class residential roads the Postmaster-General should lay the wires underground, but with respect to the other roads he decided in favour of the Postmaster-General. He stated that in these roads it did not, in his opinion, matter in the slightest degree whether the wires were carried on a painted pole or the ordinary creosoted pole.



Schwebebahn. Ein Entwurf von Dr. ing. Ulk.

This is the idea of our humorous Berlin contemporary, *Ulk*, for a suspended electric railway, based upon the Barmen-Elberfeld railway system, which it is now sought to introduce into the German capital. We recommend it to the notice of the London Traffic Commission.

Personal.—Mr. A. P. Trotter leaves for the Continent on the 28th inst., and expects to be back on April 11th.

The employés of the B.E.T. Co., the lessees of the Croydon Corporation Tramways, have, through the general manager, Mr. T. B. Goodyer, presented an oak silver-mounted inkstand and a pair of military brushes to Mr. A. Course, one of the company's inspectors, on the occasion of his leaving Croydon to take up the position of traffic superintendent under Mr. Gray Scott, late borough electrical engineer of Croydon, who has been appointed engineer and manager of the Hong Kong Electric Railway.

We are asked to state that the firm of Lacey & Sillar, 2, Queen Anne's Gate, Westminster, and 78, King Street, Manchester, will in future practice under the title of Lacey, Sillar & Leigh.

Burton-on-Trent Corporation Tramways Committee has appointed Mr. Pilcher (assistant to the general manager of the Birkenhead tramways) as tramway traffic manager. There were 80 applicants for the post.

The governing body of the South-Western Polytechnic, Chelsea, have unanimously appointed Mr. Sidney Skinner, M.A., Christ's College, Cambridge, to the position of principal in succession to Mr. Herbert Tomlinson, F.R.S., who is retiring.

South African Notes.—*Durban.*—Mr. W. H. Milne, assistant electrician of the Durban (Natal) Harbour Electrical Department, was lately the recipient of a number of valuable and useful gifts from his colleagues on the occasion of his forthcoming marriage with Miss Baytopp, of Pine Town. The Point Electric Station had been specially decorated for the occasion, and the presentations were made by Mr. Crofts, the harbour engineer. Mr. Milne was the recipient of a trio of gifts—a marble clock, handsomely ornamented, from the electrical staff; a standard lamp by Messrs. Collins & Kessler, and a set of cutlery, the gift of Messrs. F. Hadfield & Co. A gold bracelet was also presented to Mrs. Milne elect.

At Durban, on March 1st, an Indian was charged at the local police court with stealing electric current by placing a match in the meter, thereby preventing the register moving, although it did not stop the current. The case was adjourned.

Knight Central, Ltd.—In the accounts of this (Witwatersrand) mining company for the year ending December, 31st, 1903, the schedule for electrical equipment and plant is put down at £17,040 under the following headings:—Electric lighting plant, &c.; electric power plant; joint electric power plant for Knight Central, Ltd.; and Witwatersrand Deep, Ltd.

Wireless Telegraphy.—The Cape Government *Gazette* details provisions respecting the installation or establishment of wireless telegraphy in Basutoland and Bechuanaland. A licence is required before any person may "establish or use any apparatus," and this the Resident Commissioner is empowered to issue, and, if need be, to revoke at his discretion. £100 is the figure, and the penalty for contravening the regulation imposed is not to exceed £250, or in default three months' imprisonment. For a second offence a fine, not exceeding £500, may be inflicted, or six months' imprisonment in default.

Brandfort (Orange River Colony).—A correspondent writes:—"We have recently had a gentleman from Winburg canvassing for the supply of electric light here, similar to that in vogue in Winburg. The scheme would seem to be very good, and if sufficient support can be got, and our Council's sanction, doubtless we shall soon have this improvement."

British East Africa.—A concession has been obtained for the purpose of using one of the waterfalls near Nairobi to generate power which will be employed for the electric lighting of the town.

Harrismith.—The local correspondent of a Durban contemporary mentions that the only firm of electrical engineers in Harrismith "has introduced to a good many private houses and public places, stores, &c., the electric light. . . . . In the new McDonald Forbes' building, on one of the ground floors, a store front is brilliantly lighted with the electric light. The Corporation plant will be erected near the showyard on the banks of the Wilge River."

Johannesburg.—The amount of Messrs. Siemens's tender for the gas engines and electric generating plant for Sections C, D, and E of specification No. 2, as recommended for acceptance, was £154,320. The tender of Messrs. Poetter & Co., for gas producer plant and accessories, Section "A," at £50,600, was recommended for acceptance, according to South African papers just to hand.

Radium.—A Reuter telegram from Vienna states that at the request of the Academy of Science, the Austrian Minister of Agriculture, in order to facilitate the solution of certain important questions relating to the nature of radium, has ordered that from January 1st last, until further notice, no trading should be permitted in the residues from the manufacture of uranium colours at Joachimsthal, and that 10,000 kilogrammes of those residues should be reserved for purchase by the Academy and another 10,000 kilogrammes for M. Curie, the discoverer of radium, in Paris. These consignments are to be devoted entirely to the purpose of scientific experiment.

Royal Institution. — The arrangements for Friday evening meetings after Easter include the following:—

May 20th.—Prof. Ernest Rutherford, M.A., D.Sc., F.R.S., on "The Radiation and Emanation of Radium."

May 27th.—His Serene Highness Albert Prince of Monaco, on "The Progress of Oceanography."

June 3rd.—Prof. Svante Arrhenius, of Copenhagen, Hon. Mem. R.I., Hon. F.C.S., on "The Development of the Theory of Electrolytic Dissociation."

The lecture arrangements include three lectures (5 p.m.) on "Dissociation," by Prof. Dewar (Fullerian Professor of Chemistry, R.I.), on April 14th, 21st, 28th.

Magneto-friction.—M. Pellat, in the *Comptes Rendus*, March 7th, gives the following general law for magneto-friction, which is a fundamental property of the moving corpuscles of cathodic and anodic rays. The law runs: In an intense magnetic field the moving corpuscles (cathodic rays) suffer the action of an anisotropic friction, which is considerable in a direction perpendicular to the lines of force, and null, or almost null, in the direction of these lines.

Batteries and Phosphorescence.—M. Jegou has shown that a Leclanché cell, after being short-circuited for some seconds, enhances the brightness of phosphorescent sulphide of calcium held near it, and the effect has been ascribed to N rays accumulated in the cell and traversing the wire connecting its poles, as well as to the action of a non-uniform magnetic field on the sulphide. M. Lambert now adds to the subject the observation that N rays are developed in the cell by chemical action whilst it is short-circuited,

and, by polarisation, after the circuit is opened. In the *Comptes Rendus*, March 7th, he states that a bichromate of potash cell, where the chemical action continues on open circuit, emits the rays without first having to be short-circuited. The osmosis in certain cells with porous pots can also increase the brightness of the sulphide. He was led to make this observation by finding that soluble ferments emit the N rays. Two solutions of a different osmotic tension, separated by parchment, or even two solutions of the same electrolyte of different densities, separated by parchment, also increase the phosphorescence.

THE CENTRAL STATION ENGINEER.

At a joint meeting of the Aberdeen Tramways and Gas and Electric Lighting Committees on Tuesday last week, it was agreed to recommend that the salary of Mr. J. A. Bell, the electrical engineer, be increased by two yearly increments of £100 to £700. It is proposed that the Gas and Electric Lighting Committees pay four-fifths, and the Tramways Committee one-fifth of the whole salary.

Mr. Chas. W. Lund, A.I.E.E, of the London and North-Western Railway Electrical Department, has been appointed by the Colonial Office to be Assistant Superintendent of Telegraphs in Ceylon. Mr. Lund sails from London for Colombo by the P. & O. mail steamer *Australia* on May 13th.

Mr. W. J. W. Bullock, late mains superintendent and assistant to the West Ham electrical engineer, has been appointed by that Corporation electrical engineer. Mr. J. K. Bock, who has resigned his position as electrical engineer of West Ham, to take an appointment in Buenos Ayres with Messrs Livesey, Son, & Henderson, civil engineers, has been granted by the West Ham Corporation an honorarium of 100 guineas in recognition of his successful work.

NEW COMPANIES REGISTERED.

Carbone Arc Lamp Syndicate, Ltd. (80,279).—This company was registered on March 9th, with a capital of £9,880 in £1 shares (9,500 ordinary, 190 "A" deferred and 190 "B" deferred), to acquire from A. Stevenson the benefit of certain existing inventions relating to electric lamps, and to carry on the business of lamp manufacturers, electrical and mechanical engineers, tool and implement makers, &c. The first subscribers (each with one share) are:—A. Stevenson, Corner Croft, Hale, Ches., manufacturer; J. W. Nasmith, 33, Barton Arcade, Manchester, engineer; E. W. Cowan, West Bank, Disley, Ches., civil engineer; L. Andrews, 14, College Land, Deansgate, Manchester, electrical engineer; E. E. Johnson, 73, King Street, Manchester, chartered accountant; A. H. Stevenson, Victoria Mills, Pollard Street, Manchester, manufacturer; and T. R. Lawley, 12, Tennyson Street, Manchester, managing clerk. No initial public issue. The number of directors is not to be less than four nor more than seven; the first are M. Bartholomew, E. W. Cowan, J. H. Leather, J. W. Nasmith, A. Stevenson and H. Wollheim; qualification, 100 ordinary or 20 deferred shares.

Electric Heating Corporation, Ltd. (80,344).—This company was registered on March 15th, with a capital of £25,000 in £1 shares, to acquire as from March 17th, 1904, the business carried on at 34, Leadenhall Street, E.C., as the Electric Heating Corporation, to construct, deal in, and repair electric stoves for heating, cooking and other purposes, and to carry on the business of electricians, manufacturers, metal founders, general contractors, &c. The first subscribers (each with one share) are:—W. Grover, 57, Tollington Park, N., company director; A. Richardson, 56, Knox Road, Forest Gate, law stationer; E. A. Richardson, 42, Dunbar Road, Forest Gate, clerk; D. H. C. Paterson, 18, Kinver Road South, Sydenham, commission agent; E. Stephenson, 82, Bishopsgate Street, E.C., commission agent; C. H. Showler, 4, St. Mary Axe, E.C., clerk; and F. H. Williams, 30, Queen's Gardens, Ilford, clerk. No initial public issue. The number of directors is not to be less than two nor more than five; the first are H. Binko (managing director) and N. Mayer; qualification of H. Binko, 5,000 shares; of N. Mayer, 1,000 shares; of other directors, 500 shares; remuneration of H. Binko, £500 per annum; of N. Mayer and other directors, £100 each per annum. Registered office, 34, Leadenhall Street, E.C.

Andyer, Ltd. (80,368).—This company was registered on March 16th, with a capital of £1,000 in 1s. shares, to acquire any patents or rights and any inventions relating to the generation, production, projection and distribution of electricity or electric impulses, or to the detection, discovery, localisation and determination of the position of underground metallic lodes or bodies of ore, metals, minerals and other substances, or to the application by electricity to any mining or metallurgical operations, to adopt an agreement with E. J. Dyer and others, and to carry on the business of electricians, engineers, metallurgists, quarry prospectors, melters, refiners and manufacturers of oil and other substances, &c. The first subscribers (each with one share) are:—G. C. Hobday, Aulie, Blenheim Gardens, Wallington, Surrey, gentleman; G. Davey, 209, Newington Butts, S.E., confectioner; H. Kipping, St. John's Road, Sevenoaks, gentleman; A. D. Smith, 53, Sotheby Road, Highbury, N.; T. C. Cleary, 53, Clissold Road, Stoke Newington, N., gentleman; F. Crowfoot, 2, St. Paul's Villas, St. Paul's Road, Tottenham, N., gentleman; and C. J. Bridge, 50, Leconfield Road, Canonbury, N., clerk. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; remuneration as fixed by the company.

Sir Hiram S. Maxim Captive Flying Machine Co., Ltd. (80,404).—This company was registered on March 19th, with a capital of £80,000 in £1 shares, to acquire any interest or rights to use any invention relating to captive flying machines or rotating cars for public recreation or experimental purposes, and for apparatus for actuating the same, in particular to acquire from the Sir Hiram Maxim Electrical and Engineering Co., Ltd., the benefit of certain existing inventions in relation to rotating cars and apparatus, to construct, erect, equip, maintain and enter into contracts for the construction, erection, equipment and maintenance of such captive flying machines, rotating cars and apparatus, and to carry on the business of caterers for public amusement, &c. The first subscribers are:—Sir H. S. Maxim, Kt., Thurlow Park. West Norwood, 2,000 shares; F. de Meray, 1, Rutland Gate, Hyde Park, W., gentleman, 4,000 shares; W. F. B. M. Manwaring, M.P., 80, Grosvenor Place, S.W., 1,000 shares; J. Woolf, jun., 809, St. James's Court, S.W., engineer, 1,000 shares; A. Hardie, Wynnstay, Cyprus Road, Finchley, barrister, 1,000 shares; A. Davidson, 21, Lanercost Road, Tulse Hill, engineer, 100 shares, and R. G. Graham, 65, London Wall, E.C., gentlemen, 900 shares. Minimum cash subscription 10 per cent. of the shares offered to the public. The number of directors is not to be less than two nor more than seven; the first are Sir H. S. Maxim, Kt., A. Hardie, J. Woolf, jun., and A. Davidson; qualification, £100; remuneration, 10 per cent. of the net profits after 20 per cent. dividend has been paid, divisible. Registered office, 44, Gillingham Street, Westminster.

Madras Electric Tramways (1904), Ltd. (80,361).—This company was registered on March 16th, with a capital of £100,000 in £1 shares, to purchase, lease, construct or otherwise acquire any tramway or tramways in Madras or elsewhere, to equip, maintain and work by electricity, steam or other mechanical power or by animal traction, any tramways belonging to the company, or over which the company has any rights, and to carry on the business of tramway proprietors, carriers of passengers and goods by land or water, omnibus and van proprietors, builders of tramway and railway carriages, trucks, locomotives, rolling stock and plant, mechanical engineers, electricians, producers and suppliers of electricity for motive power, light, heat, or other purposes, &c. The first subscribers (each with one share) are:—H. Twelvetrees, 89, Clapton Common, N.E., accountant; D. Wilson, Earlsdown, Dollis Park, Finchley, secretary; H. C. Truscott, 12, Hazeldene Road, Chadwell Heath R.S.O., Essex, clerk; A. J. Smith, 53, Jerningham Road, New Cross, S.E., clerk; J. R. Threadgold, 6, Osborne Villas, Elvine Road, Sydenham, clerk; J. H. Staples, 70, Dalston Lane, N.E., clerk; and M. J. Saunders, 30, Camden Grove, Peckham, S.E., clerk. No initial public issue. The number of directors is not to be less than three or more than seven; the first are Sir H. C. Mance, J. W. Barclay, J. I. Courtenay and J. Gray; qualification, £250; remuneration, £100 each per annum.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Costa Rica Electric Light and Traction Co., Ltd. (56,447).—This company's annual return was filed on January 20th, when the entire capital of £130,000 in £1 shares had been taken up. £1 per share has been called up on 7, resulting in the receipt of £7. 129,993 shares are considered as fully paid. Mortgages and charges: £129,650.

Mazarron Electric Light Co., Ltd. (38,277).—This company's annual return was filed on January 14th, when 151 preference and 10,000 ordinary shares had been taken up out of a nominal capital of £15,000 in 500 preference shares of £10 each and 10,000 ordinary shares of £1 each. £10 per share has been called up on 151 preference, and £1 per share on 7 ordinary shares, resulting in the receipt of £1,517. 9,993 ordinary shares are considered as fully paid. Debentures: £820.

Langdon-Davies Motor Co., Ltd. (55,830).—Issue, on March 8th, of £400 4½ per cent. debentures, part of series created October 15th, 1902, to secure £6,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £5,400.

Brockie-Pell Arc Lamp, Ltd. (66,602).—A memorandum of satisfaction in full of a debenture dated November 30th, 1903, securing £1,000, has been filed.

Uxbridge and District Electric Supply Co., Ltd. (62,706).—Issue, on March 7th, of £3,900 debentures, part of series created by resolutions of July 18th, 1901, and May 26th, 1903, to secure £25,006, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £20,000.

National Telephone Co., Ltd. (15,066).—A trust deed of March 3rd, 1904, to secure £425,000 4 per cent. debenture stock (being supplemental to a principal trust deed dated December 30th, 1899, securing £600,000, and to first and second supplemental deeds dated October 8th, 1900, and October 21st, 1901 (the latter securing a further £775,000 debenture stock), has been registered. The total amount authorised is three-quarters of the issued capital for the time being (inclusive of £2,000,000 3½ per cent. first debenture stock previously issued). Property charged: The company's undertaking and property, present and future, including uncalled capital (subject to first debentures). Trustees: Sir M. M. Thomson, Bart., 6, Charlotte Square, Edinburgh; and Sir F. F. Adam, Knight, Mere Old Hall, Knutsford, Ches. Total amount now secured of present series: £1,800,000.

CITY NOTES.

Marconi's Wireless Telegraph Co.

The report for the year ended September 30th last, to be submitted at the meeting at the Cannon Street Hotel, on 30th inst., states that profits have increased, notwithstanding the fact that no revenue has as yet been earned by the stations for trans-Atlantic telegraphy, the commercial working of which is looked upon as likely to prove the most profitable branch of the business. From the reprint in the *Financial Times* we see that "during the past year Mr. Marconi has, in connection with the long-distance work, been carrying on a number of experiments, the results of which make for the improvement and perfecting of the long-distance communication. The application of some of these improvements to a station equipped on a commercial scale would involve considerable outlay; and in the absence of those facilities from the Post Office which would alone render such an outlay of utility, the board has not thought fit to authorise the equipment of a new trans-Atlantic station embodying all those improvements, which would render practicable good commercial working both by day and night, on a scale which for speed and reliability would compare with that of a trans-Atlantic cable. The collection and distribution of telegrams throughout the United Kingdom being a monopoly of the Postmaster-General, it is obvious that it is impracticable for this company to carry on a trans-Atlantic service of any advantage without the assistance of the Postal Telegraph service, upon which it is dependent for the collection and transmission of its messages. Such facilities, similar to those granted to the cable companies, have not yet been obtained. Recent negotiations seems to offer some prospect of satisfactory arrangements to this end. If and when these arrangements are concluded, the equipment of a trans-Atlantic station on a commercial basis, capable of rendering a service at least equivalent in speed and reliability to the service rendered by any single cable, will be proceeded with. The actual erection of the station will, it is expected, occupy not more than six months; so that the shareholders may hope to see Trans-Atlantic wireless telegraph stations established on a commercial basis within a few months of obtaining from the Post Office the necessary facilities. Should satisfactory arrangements not be offered by the British Government, the European station will be erected in one of those Continental countries which have already agreed to give

facilities for inland distribution and collection of telegrams similar to those which are asked of His Majesty's Government. In July last a new contract was entered into with the Admiralty, covering the use of this company's system throughout His Majesty's fleet. Provision is made in the contract for the payment annually of a royalty; considerable orders for further apparatus have already been placed, and it is hoped that the relations which now obtain between the Department and this company will result in mutual benefit. In pursuance of the contract a number of H.M. ships have already been equipped with tuned apparatus, and, in a demonstration which took place of long-distance wireless telegraphy, messages were received from Poldhu on H M S. *Duncan* throughout her voyage from Portsmouth to Gibraltar. These tests were watched by naval officers on the ship and at Poldhu, and in the report to the Admiralty testimony was borne to the fact that other ships of H.M. Navy, within range of the Poldhu station, but not similarly tuned, were unable to intercept the messages, and were not interfered with in their own work by them. In Canada a Bill has passed the Legislature providing for the equipment of wireless telegraph stations in the St. Lawrence. All the stations, subject to the approval of the Imperial Government, to whom all proposed wireless telegraph schemes are submitted by the Colonial Governments, are to be equipped on the Marconi system, under a contract to be entered into with the Canadian Co. The Italian Government has been very active in the extension of wireless telegraphy throughout Italy. A number of stations have been erected during the past year, which are available exclusively for the use of ships equipped with the Marconi system. The site for a high power station, near Pisa, for communicating with the Argentine Republic, and with the company's high power stations in the United States and Canada, has been selected by Mr. Marconi, and some of the plant for this station is already on order. Arrangements have also been made for a wireless telegraph service between Italy and Montenegro, in the benefits of which this company participates. A wireless telegraph station has recently been erected in Amsterdam in close proximity to the Stock Exchange, and Press and other messages are being transmitted between that station and a station in England. It is hoped that when the necessary facilities have been obtained from the Post Office here, the service already entered upon will be greatly extended, and that a considerable revenue will result. The company is able to transmit messages at a lower rate than they can be transmitted by existing arrangements; and as there is often considerable delay in the telegraph service between England and Holland, it is hoped that, both on the score of cheapness and dispatch, the service will represent considerable advantages. Negotiations have for some time past been going on between this company and the Board of Trade for the equipment of lightships with wireless telegraph apparatus, and the directors have been informed that a contract relating to this service is in preparation. During the year negotiations with a group of Danish financiers were entered into for the connection of Iceland with Europe by wireless telegraphy, that country being at present isolated from the world so far as telegraphic communication is concerned. The negotiations are at present temporarily suspended, partly owing to the inability to obtain from the English Post Office the facilities for an inland service which are necessary, and partly to other difficulties which it is hoped will be removed. On March 16th, 1903, a deputation of the National Sea Fisheries Protection Association waited upon Mr. Austen Chamberlain to ask for inland postal facilities for a wireless telegraph connection with Iceland, which, however, were not granted. It is hoped that this question of inland postal facilities for the Iceland connection will receive settlement as part of the general questions under discussion with the Post Office. The natural extension of this company's business in the last three years, and the general adoption of the Marconi apparatus as the standard system of wireless telegraphy for ship-to-shore service throughout the world, have attracted the special attention of the German Government, with the result that a conference for the regulation by international legislation of wireless telegraphy for shipping purposes was proposed to the Powers by that Government in May, 1903. The conference met in Berlin in August of 1903. It was of a preliminary character, and while the majority of the Powers represented were in the main in favour of inter-communication between all ships equipped with wireless apparatus, irrespective of the so-called system employed, there were two most significant reservations—those of His Majesty's Government and of the Government of His Majesty the King of Italy. Having regard to the important part played by these countries in the shipping of the world, and to the shipping routes which they, with their Colonies, command, it is felt that, even if the recommendations of the other parties to the preliminary conference should be adopted at a subsequent conference, the effect upon the company's business will not be of great consequence, while England and Italy remain outside the arrangement. The international organisation of ship and shore stations for sea telegraphy has been very greatly extended. The "Marconi" system of wireless telegraphy is in use on 48 liners. 54 shore stations are now installed, commanding the principal shipping routes, these stations being available exclusively for communication with ships equipped with the Marconi system. Among them are stations worked by the British Admiralty, the Italian Admiralty, and Lloyd's. As the stations worked by the Governments and Lloyd's are increased, an extension of the arrangements for working exclusively with ships equipped with the system will ensue. The factory at Chelmsford is now more fully employed than in any previous year of the company's existence. Orders for apparatus on a large scale have been executed, and the work now in hand, without further orders, will keep the factory fully employed for many months to come. On February 18th, 1903, last, a committee composed of members of the Government departments, presided over by Mr. Bonar Law, sat for the consideration of evidence on wireless telegraphy. It was hoped that the proceedings of this committee would elucidate some of the difficulties surrounding this subject, and pave the way to concerted action by the departments concerned. At the request of the Committee, the managing director of the company gave evidence before it. The nature of any decision arrived at has, however, not been communicated to the directors. The powers taken by the Board at an extraordinary general meeting held on March 31st last, for increasing the capital of the company, have not yet been exercised. The receipts for the year of £36,376, are £10,607 in excess of the general charges."

Harrow Electric Light and Power Co.

The directors' report for 1903 says that the revenue account shows a surplus carried to net revenue account of £3,382, as against £2,548 in the previous year. The amount at credit of the net revenue account, including £101 brought forward from last year, amounts to £3,577. After paying interest, interim dividend on preference shares, and placing an additional £1,000 to depreciation account, there is an available balance of £1,497. Out of this the directors recommend that the following dividends be paid:—Final preference dividend, £361; dividend on ordinary shares at 3 per cent., £752, leaving £384 to be carried forward.

The price to consumers was reduced from January 1st, 1904.

The number of lamps installed during the year amounted to 1,769; the number of units supplied to consumers was 229,462, an increase of 14,373 over the previous year. The works costs shows a considerable reduction, amounting to 1·87d. per unit, as against 2·24d. in 1902, and 3·02d. in 1901. The total costs amount to 2·87d. per unit in 1903, as against 3·43d. in 1902, and 4·32d. in 1901. In last year's report reference was made to the possible need for some capital outlay, with the view of rendering more efficient the boiler power of the plant installed. A scheme of steam condensing and superheating has now been adopted, and will be carried out during the ensuing year. This will not only increase the boiler power, but will reduce the consumption of coal. The directors invite applications from the shareholders for £3,000 more of ordinary shares.

The annual meeting was held on March 10th, when the report was adopted on the motion of Mr. J. N. Stuart, chairman, seconded by Mr. G. Spencer Hawes, who had recently joined the board.

Direct Spanish Telegraph Co.

The Marquess of Tweeddale presided at the meeting held on Tuesday at Electra House, and, in moving the adoption of the report (Elec. Rev., March 18th), said that the falling-off in receipts (£1,797) was partly accounted for by the general depression in trade, and perhaps more by the interruptions which had taken place in the cables, which lasted 77 days. They would recall that, in 1901, the interruptions lasted for 120 days. The cost of last year's repairs, £10,921, had been debited to the reserve fund. After a mention of the electrical tramway disturbances at Bilbao, which are referred to in the report, the chairman said that the reserve fund was now £48,621, including the £5,000 placed to it for 1903. In regard to the reduction of rates to Spain, &c, they hoped for a sufficient increase of traffic to recoup them for the loss which was certain to be entailed, though their experience did not warrant them in being very sanguine in that respect. The increase in salaries was due to the new office at Arrigunago, the new station erected on account of the electric tramway disturbance. It had been possible to effect substantial economies in stations abroad and in London, so that the net increase in working expenses was only £95. The company's licence on the shores of this country occurred on October 31st last, and they had been negotiating with the Government with a view to its renewal, and they hoped before long to enter into an arrangement satisfactory both to the Government and the company. The licence to land on the Spanish coast was a perpetual one.

The report was adopted, the dividend resolution approved, the retiring directors and auditors re-elected, and the chairman and directors thanked.

Melton Mowbray Electric Light Co.

The report for 1903 records satisfactory progress:—

The number of lamps connected increased from 8,520 to 11,028 with 421 consumers, being an increase of 29 per cent.

Including the balance of £500 brought forward from last year's account, the revenue amounts to £1,546, which, after payment of dividend and debenture interest amounting to £827, leaves a balance of £719 available for distribution.

The directors recommend a dividend at the rate of 2½ per cent. per annum (£310), and to write off the preliminary expenses (£50), which, after placing £200 to a reserve for depreciation fund, will leave a balance of £160 to be carried forward.

The contractors, Messrs. Edmundson's, having accepted in March debentures in payment of outstanding accounts, have consented to forego their interest for this year on these accounts.

Greenock and Port Glasgow Tramways Co.

The report for 1903, which was submitted at the meeting in London on the 24th inst., states that the outlay on the electrical reconstruction account during the year amounted to £5,818, making the total expenditure £176,882. There had been an increase in traffic receipts of £2,455. The total revenue for the year amounted to £29,025, and expenses to £18,219, leaving a net profit of £10,806. Adding £3,987 brought forward, there was available for distribution £14,793. The directors proposed placing to depreciation and renewals account £1,500, to reserve (sinking) fund £1,780, and, after paying a dividend of 6 per cent. on the ordinary shares, there remained to be carried forward £2,093. The depreciation and renewals account would then stand at £3,500, and the reserve fund at £3,616. The short extension in Port Glasgow had been constructed, and was opened for traffic on November 2nd, 1903.

Ernest F. Moy, Ltd.

The report for 1903 shows that a profit of £1,093 12s. has been earned, and the directors recommend that this be dealt with as follows:—

10 per cent. dividend on 7,873 ordinary shares (calculated on the new shares from the dates the instalments were received), free of income-tax	£702	0
6 per cent. dividend on 1,420 preference shares (calculated on the new shares from the dates the instalments were received), less income-tax	70	1
Income-tax on profit, £1,093 12s. 5½d.	50	2
General reserve account	200	0
And that the balance be carried forward to next year's account	71	9
	£1,093	12

The reserve has been brought up to £2,039. The directors report that although business generally in the electrical trade has been far from satisfactory, they have been able to keep the works fully employed on fairly remunerative work, and the present year has opened with a good supply of orders in hand, and every prospect of business remaining steady. Up to the present time it has not been possible to secure additional premises in the neighbourhood of the present works on satisfactory terms, but it is hoped that arrangements will shortly be completed which will give additional space, and so enable them to increase the output.

Evered & Co., Ltd.

The report for 1903 shows, after providing for debenture interest and income-tax, a net profit of £14,688; adding £5,114 brought forward, the amount available is £19,802. After paying 8 per cent. for the year on the shares, writing £1,000 off buildings and £1,000 off plant, £4,143 is carried forward. The directors consider that the result of the year's trading is satisfactory, having in view the depressed state of trade and the consequent excessive competition. During the year the scheme of electrifying the plant at Surrey Works was completed.

Edwards Air Pump Syndicate.

Mr. C. W. Milne presided at the annual meeting held at the offices, on 17th inst., and made a very satisfactory statement regarding the increase of business, and the decreased expenses. In regard to Corporation orders, he said that five years ago, the central station engineer who specified the Edwards type of pump was regarded as a brave man, but to-day the engineer who did not specify them was taking altogether unnecessary risks. They had not had a single instance where a Corporation engineer who had adopted their pump had ever reverted to the old type again. Particular attention was now being given to pumps for steam turbines. The report was adopted, and the 10 per cent. dividend approved.

City of Birmingham Tramways Co.

Mr. Garcke presided at the meeting held on 17th inst.. The decision of the Corporation to municipalise the tramways within the city had made the future of the company somewhat uncertain. The financial condition of the company was a strong one, notwithstanding the expiration of some of their leases in 1906 and 1911. In view of the policy of municipalisation of the tramways, the directors had no alternative but to make the most of what remained to the company. The company would have a considerable mileage outside the boundary of Birmingham after the leases in the city had expired. The idea was to construct new authorised lines, and to convert the lines outside the city to electric traction. The Council had spoiled the provision of what might have been one of the finest systems of electric tramways in the country. The company would endeavour to make arrangements with the Corporation for through running powers. The directors had under consideration a proposed working arrangement with the Birmingham and Midland Tramways, Ltd. The report was adopted.

Cork Electric Tramway and Lighting Co.

Mr. A. R. Monks presided at the meeting held on 18th inst., at 83, Cannon Street, E.C., and said that the traffic during 1903 had been affected by bad weather. Electric power demand was increasing satisfactorily. The total equivalent of additional lamp connections was in excess of the average of former years. The outlook for 1904 was good, especially bearing in mind the approach of the King's visit.

Oldham, Ashton and Hyde Electric Tramway Co.

Mr. Garcke presided at the meeting held at Hamilton House on 18th inst. He attributed the decrease in the dividend to special circumstances. The traffic receipts were £2,000 in advance of the previous year, but the working expenses had increased in greater ratio because of the bad weather, depressed state of trade, and the fact that a line leased from the Hyde Corporation was not yet remunerative. The capital expenditure incurred during the year was mainly for providing extra cables which would produce economies in consumption of energy. The report (see Electrical Review, March 18th) was adopted.

Northern Counties Electricity Supply Co.

The directors' report for 1903 says that the progress made in the working operations is shown by the following figures relating to Blyth, Spennymoor, Alnwick, Hebburn, Thirsk, and Whitley, the three last named places having been in operation for a portion of the year only:—

Consumers connected to Dec. 31st, 1903	2,482
Equivalent in 8-c.p. lamps connected to Dec. 31st, 1903	39,639
Units sold for year ending Dec. 31st, 1903	344,781

The Ashington supply was commenced towards the end of the year, and the Hartlepool and Morpeth power stations have since been started. Up to date, therefore, nine stations or sub-stations are at work, and the Malton and Shildon generating stations and Felling sub-station will be in operation during the current year. At Ashington and Whitley the company is taking its supply in bulk, and by agreement with the Cleveland and Durham County Electric Power Co., current will be supplied to the company in bulk in the North-West Durham area, which includes Consett, Annfield Plain, Benfieldside, Stanley and Leadgate, and it is expected this area will be in operation during the current year. By means of these arrangements the cost of erecting generating plant is avoided. In addition to the lighting connections, both public and private, important power consumers have been obtained, and there are others in prospect. The directors therefore anticipate a business of considerable magnitude, with a steady reduction in the cost of production as the load factor in each area improves. As already stated, the number of units supplied in the year just closed amounted to 344,781, and during the current financial year the directors expect such an increase in the company's business as will command a substantial revenue. With regard to the operations of 1903, after an apportionment of charges between construction and revenue accounts, there remains a credit balance of £1,000 12s., which the directors propose to carry forward and trust that they may be able to pay a dividend for the year now entered upon. In accordance with the intention expressed in the previous report, the directors issued 50,000 new shares to the existing shareholders at par. Of these, up to date 35,463 have been taken up, leaving 14,537 still to be subscribed, which the directors do not doubt will be done by the shareholders themselves. In order to pay off existing loans and complete the stations at present in hand the directors propose to issue debentures.

Woking Electric Supply Co.

The directors' report for 1903 is as follows:—

The total revenue for the year ending December 31st, 1903, was £7,960, and the generation and distribution of electricity and management expenses amounted to £4,043, leaving a balance on the year's working of £3,917. Adding £675 brought forward, there is a total of £4,593, which it is proposed to appropriate as follows:—

Interest on the 4½ per cent. debentures	£1,049
Interest on temporary loans	341
Dividend on the 6 per cent. cumulative preference shares ..	792
Dividend of 4 per cent. per annum on the ordinary shares ..	626
Depreciation fund account	750
	£3,558
Leaving a balance to be carried forward of	1,035

The amount to be carried forward to next year is sufficient to pay the ordinary shareholders a much larger dividend, but the shareholders are asked to approve the policy of carrying forward a large balance. The following table will show the rate at which the company's business has progressed during the last four years:—

	No. of consumers.	Lamps connected.	Revenue. £ s. d.
1900	294	11,400	4,002 5 11
1901	417	15,090	4,466 15 0
1902	543	19,566	6,276 2 5
1903	660	25,010	7,951 15 10

During the year 136 new consumers were obtained, exclusive of the L. & S.W. Railway Co.'s lighting of Woking Station, which was connected in December last, and which is already a very large consumer of electrical energy. The directors consider that the outlook for the future is most promising.

During the year the directors have issued £3,850 4½ per cent. debentures, and £9,210 6 per cent. cumulative preference shares, and they are now looking towards issuing the balance of the debentures, preference and ordinary shares. The expenditure on capital account on December 31st, 1903, amounted to £65,480. During 1903 a new engine room has been built, a 400-kw. generator installed (more than doubling the generating capacity of the works), a new switchboard of the most modern type erected, and eight miles of cable laid down, including a special one between the works and the railway station. Further expenditure upon boiler power and other works will be required during the current year. The necessity for the increased capital expenditure is owing to the rapid and continuous growth of the business of the company, which has largely exceeded the anticipations of the directors. The directors record the excellent work done by Mr. J. G. McLean, the company's engineer and manager, by Mr. W. Strayton, the secretary, and by the staff generally.

Tynemouth and District Electric Traction Co.

The annual meeting was held on the 17th inst. at Cullercoats, Mr. W. J. Greer presiding.

The Chairman, in moving the adoption of the report, congratulated the company on the good results obtained despite the bad weather of the 12 months under review. The traffic receipts had increased by £720, while the expenses generally showed a decrease of £295. A sum of £4,158 had been expended on capital account, making it £85,314. They would remember that owing to the excessive demands made by the Tynemouth Corporation, they had had to abandon the new lines to Preston, proposed in the Bill. He regretted that it had been impossible to complete the extension to Whitley Sands, but they hoped to be able in a short time to give orders for the work to be put in hand.

Mr. J. H. Robinson seconded the motion.

It was stated that the number of passengers carried up to date this year had been 334,542, as against 349,827, but as against this they had been able to effect certain savings. The report was adopted, and the retiring directors were re-elected.

Dover Electricity Supply Co.

The directors' report for 1903 says that the steady growth of the business has been well maintained, and the results obtained during 1903 are highly satisfactory.

Applications have been received for an equivalent of 3,700 8-c.p. lamps, the total connections now amounting to the equivalent of about 27,400 8-c.p. lamps. The output to private consumers was 566,506 units, being an increase of 62,685 units over the previous year. The continued expansion of the business has necessitated a capital expenditure of £7,715, the principal items being £2,878 for the extension of the mains in various parts of the town, and £3,214 for additional generating plant, rendered necessary by the greatly increased demand upon the station. The profits upon the year's working, for which the Dover Corporation will be entitled to take credit upon the completion of their purchase, amount to £6,873. No provision has been made for the setting aside of a sum to depreciation fund account, the directors being of opinion that, having regard to the fact that the undertaking is being worked for the benefit of the Dover Corporation, it would be more desirable to let the Corporation deal with this matter themselves upon coming into possession. The amount available for distribution by the company is the sum of £9,669, being interest at the rate of 4 per cent. per annum upon the purchase price, payable by the Corporation under the contract of sale. After providing for the debenture and other interest charges, the directors recommend the payment of the full dividend of 5 per cent. on the preference shares, requiring £1,250, and a dividend of 6 per cent. on the ordinary shares, amounting to £3,000, leaving a balance to carry forward of £120.

Electric Lighting and Traction Co., of Australia.

The directors' report for the year ended August 31st, 1903, says that during the year, capital expenditure in Australia on buildings, plant and mains has been incurred as follows:—Melbourne, £10,217; Adelaide, £15,573; Geelong, £1,833; total, £27,623.

The second moiety of £75,000 5 per cent. first mortgage debenture stock was sold in March, 1903, and of the proceeds, a portion was utilised for pressing capital requirements in Australia, and the remainder applied in reduction of the loan from the company's bankers, which, on August 31st, 1903, stood at £78,670. The profits derived during the year from the company's undertakings in Australia amount to £6,249. Management and general expenses at the London head office amount to £2,318, and debenture and bank interest to £9,278. After payment of these charges, and writing off repairs and renewals incurred during the year, and also a deficit of £71 10s. on the Port Adelaide undertaking, there is a balance to the debit of profit and loss account of £7,442. The company's business during the year has been seriously prejudiced by the general depression in Australia, consequent upon the prolonged drought. The present outlook is, however, more hopeful, due to better harvest prospects and other causes, and this improvement is reacting favourably upon the company's business, the connections for light and power during the first four months of the current year showing a satisfactory increase over the corresponding period of last year. Substantial economies have been effected during the year in working expenses, the average cost per unit sold showing a reduction of 25 per cent. as compared with the previous year. The total connections to the company's mains in Australia on August 31st last amounted to the equivalent of 89,600 8 c.p. lamps, showing an increase of 23,000 8-c.p. lamps over the connections existing at August 31st, 1902. During the first four months of the current year, the equivalent of 12,500 8-c.p. lamps has been applied for and connected. The engineer and manager in Australia, Mr. F. W. Clements, reports that there is a growing demand for the use of electric power in connection with the company's undertakings, over 400 h.p. having been added to the mains during the year under review. All possible efforts are being made to encourage this source of revenue by means of a revision of the company's tariff of charges and in other ways. The directors have been approached by influential Australian interests desirous of participating by means of local capital and representation in the company's undertakings. The negotiations are receiving the careful attention of the directors.

Melbourne.—The profit and loss account shows a gross profit for the past year of £2,094. The effect of the administrative and working economies which have been carried out during the 12 months, will no doubt be felt more fully during the current year. The directors believe that the Melbourne undertaking will eventually become the company's most profitable asset, but its development must necessarily be a matter of time, owing to the large suburban areas over which electric supply has to be provided, involving heavy capital outlay in advance of revenue returns.

Adelaide.—This station continues to make good progress, the financial result for the past, its second, year of working, being a gross profit of £3,449 13s., as compared with £500 for the previous year. The additional connections secured amount to the equivalent of 16,200 8-c.p. lamps, and further applications for light and power continue to be received at a satisfactory rate.

Geelong.—This station has earned a gross profit of £705 during the year, and has added the equivalent of 4,850 8-c.p. lamps to its mains. Several important contracts for the supply of power are being negotiated, and the prospects generally of the Geelong undertaking are favourable.

Port Adelaide.—This small station has continued to work at a loss, but the latter has been reduced by careful management to £71 10s., as compared with £435 for the previous year. It is anticipated that expenses will be covered during the current year, and, in these circumstances, the directors do not propose to press forward with the preparations for closing the station and supplying the district from Adelaide.

The directors record with satisfaction that the chairman, Mr. J. B. Braithwaite, jun., took the opportunity of a recent visit to Australia, to inspect the company's various stations and examine personally into their position and prospects. He will place his views before the shareholders at the meeting on Monday next.

Stock Exchange Notices.—Application has been made to the Committee to allow the following to be quoted in the Official List:—Bromley (Kent) Electric Light and Power Co., Ltd.—14,000 ordinary shares of £5 each, fully paid; National Telephone Co., further issue of £89,593 4 per cent. debenture stock. Also to appoint a special settling day in, and to grant a quotation to—Metropolitan Railway Co.—Scrip (fully and partly paid) of £500,000 3½ per cent. convertible preference stock; National Telephone Co.—Scrip (fully and partly paid) of a further issue of £1,000,000 4 per cent. debenture stock.

Buenos Ayres and Belgrano Electric Tramways Co.—The directors recommend a dividend of 3 per cent., or 3s. per share, free of tax, on the ordinary shares, after making the following allocations out of net revenue:—To renewals fund, £5,000; to sinking fund for redemption of debenture capital, £2,500; written off capital expenditure, £4,500; to accidents insurance fund, £500; to meet a loss on sale of surplus stores, £1,301, leaving £2,479 to carry forward.

Direct United States Cable Co.—Interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum for the quarter ending March 31st, 1904.

STOCKS AND SHARES.

Wednesday Evening.

Renewed borrowing with Government guarantee has caused a reaction in Consols since we last wrote, but, taking the general circumstances of the situation into account, investment markets are steady, without displaying much feature. With Easter so close at hand, to say nothing of the fag-end of a 19-day account in the Stock Exchange, a fresh spurt in business can hardly be looked for, but the markets are sound enough underneath. Unfortunately, it is difficult to avoid the impression that there will be other heavy issues of stock before long, and the knowledge of their probable advent is not conducive to better prices—and, therefore, better business—in the departments devoted to higher-class varieties.

Although none of the purely electrical railway stocks have varied in price, there are several items of interest in this section that deserve notice. Lancashire and Yorkshire stock has recovered appreciably, partly on the collapse of Sully, the cotton gambler—which should assist the Lancashire cotton trade to regain some of its prosperity—and partly upon the electrification of a portion of its line. The newly-electrified part has just been opened for traffic and in several respects it is unique, as may be seen in our other columns. Metropolitan District Ordinary hardened a point to 33, upon a further reduction in the fares from Hammersmith to the East End. The change is to date from April 1st. Central Londons are unaffected by this step which appears to be taken in order to bring the District's third-class fares into line with that charged by the Twopenny Tube. Metropolitan Consolidated remains steady, but the new 3 per cent. convertible Preference stock has risen to 3 premium, at which it still looks cheap enough to buy in view of the company's prospects when the line is electrified. Great Northern and City Preferred "A" have dropped a pound to 6, and it is said that the new line is not answering expectations. The present, however, is too early to admit of any reliable deductions being made.

London United Tramways Preference, after being 11, have recovered to 11¼, and the Debenture Stock is 102. Dublin United Ordinary are 13 and the Preference 15½. A capital dividend announcement by the Anglo-Argentine Tramways Co. has raised the Preference to 4⅞. Besides paying 5 per cent. upon these shares, the Anglo-Argentine Tramways declares 6 per cent. on the Ordinary, and makes substantial grants to the reserve and to the carry-forward. British Electric Traction Ordinary are dull at 9, having fallen 10s., and the Preference the same sum to 10½. In view of the absence of support accorded to these issues, and the steady sales of small quantities of shares, we are prepared to see lower levels before any improvement sets in. Calcutta Trams are 7, and the Debenture stock was bought the other day at 106¾. Metropolitan Electric Deferred are easier at 3s. 6d., and the Preference shaded off to 18s. 9d. upon rumours of a new Debenture issue.

Fluctuations in the Electricity Supply companies quoted overleaf are limited to one solitary fall of ¼ in London Electric Ordinary which reduces the price to 1¼. Amongst the markings in the Stock Exchange Official List of business done this week there may be noted bargains in Charing Cross Preference at 5½, manifestly a sale and Chelsea Ordinary at 6 1/16, which looks like a purchase. Metropolitans are strong at 18½, the position of the company being considered so secure as to give shareholders little or no cause for nervousness. The Borough Council of Marylebone are now taking definite steps with a view to raising the necessary purchase money due to the Metropolitan Co.

Telegraph stocks and shares are a trifle more active, but there is not much change to report. Anglo-Americans are unaltered Commercial Cable is quoted 182 to 188, being a narrower price, but with the same medium as before. Direct United States at 10¼ have added the fraction to their price, and the usual 3s. dividend is declared. Great Northerns rose a further 10s. to 25 upon purchases induced by the recent unwarranted fall. Eastern 3½ per cent. Preference is down a point to 87½, whilst West India and Panama First Preference have fallen ¼ to 6. West Coast of America Ordinary are about 3s. 9d. per share, the Debentures standing at 96½. These latter are, of course, guaranteed by the Western Telegraph Co. Globe Ordinary at 8⅝ have put on 5s.

National Telephone varieties, like Telegraph stocks, are somewhat more active. The 4 per cent. Debenture stock is down 1½ points to 98½, owing to the new issue, the price of which has improved to 1 premium, *i.e.*, to 99 for the fully paid stock. The other National descriptions show a rise of a point each in the Preferred and Deferred stocks, while those in the remaining telephone companies are unaltered on the week.

Prospectus.—*Madras Electric Tramways (1904), Ltd.*—Subscriptions are being invited until to-morrow (Saturday) for an issue, at par, of £50,000 5 per cent. debenture stock.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations March 16th.	Closing Quotations March 23rd.	Business done week ended March 23rd, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	.. — ..	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	48 — 51	48 — 51	48½	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	91 — 93	92½	91½
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	6⅞ — 7⅛	6⅞ — 7⅛	7	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4⅞ — 5⅛	4⅞ — 5⅛	5 7/16	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	180 —190	180 —190	182	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 91	90 — 92	91	90
16,000	Cuba Telegraph	10	4 %	6½%	..	7 — 8	7 — 8	7⅞	7½
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,981	Direct Spanish Telegraph	5	4 %	4 %	..	2¼ — 3½	2¼ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7½ — 8½	7½ — 8½	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101⅝	98 —101⅝	..	..
60,710£	Direct United States Cable	20	8½%	8½%	..	9⅜ — 10⅝	10 — 10⅝	10½	10 5/16
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	117 —122	117 —122	121	118½
1,955,665	Do. 8½ % Pref. Stock	100	..	..	..	87 — 90	86 — 89	86½	86
1,534,845	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	104 —107	106½	104⅞
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10⅜ — 11⅛	10⅜ — 11⅛	11⅛	10 15/16
820,000£	Do. 4 % Deb. Stock	Stock	..	..	..	103 —106	103 —106	..	..
900,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	98 —101	98 —101	..	..
900,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 3,000	25	..	..	..	99 —102	99 —102	..	..
180,297	Globe Telegraph and Trust	10	5½%	..	..	8¼ — 8¾	8 — 8½	8 5/16	8¼
180,043	Do. do. 6 % Pref.	10	..	..	..	12 — 12½	12 — 12½	12⅜	12¼
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	24 — 25	24⅛ — 25⅛	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	38 — 41	38 — 41	41	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —103	100 —103	..	..
1,993,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	99 —101	100 —102	100⅞	99½
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	73 — 76	74 — 77	75½	73½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	14	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13½ — 14½	13½ — 14½	14 1/16	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	5⅛	5 1/16
600,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 96	94 — 96	94½	94
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	99 —101	97 — 99	99	97½
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞ — 1	⅞ — 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6½ — 7⅛	6½ — 7⅛	..	..
3,803	Submarine Cables Trust	Cert.	..	..	..	115 —120	115 —120	119¾	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5½ — 6	5½ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5½	4½ — 5½	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 267,930	10	7 %	7 %	..	11¾ — 12½	11¾ — 12½	12⅜	12
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	102⅞	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜ — ½	⅜ — ½	..	..
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	5⅞ — 6⅛	5 15/16	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½ — 5⅝	4½ — 5⅝	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,600	100	..	..	..	99 —102	99 —103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4 — 5	4 — 5	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	89 — 94	89 — 94	..	..
100,000	British Electric Traction	10	9 %	8 %	..	9 — 10	8½ — 9½	9¾	8¾
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	10 — 11	9½ — 10½	*10¾	9¾
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	..	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	6 — 6½	6 — 6½	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½ — 5⅝	5½ — 5⅝	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅝ — ¾	⅝ — ¾	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	½ — 1	½ — 1	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	¾ — 1⅛	¾ — 1⅛	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	96 — 99	96 — 99	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	72 — 77	72 — 77	..	..
85,000	Callender's Cable Construction shares	5	20 %	15 %	..	10½ — 11½	10½ — 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½ — 5⅞	5½ — 5⅞	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	92 — 95	92 — 95	93¾	93½
494,098	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	98 —101	98 —101	99½	..
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	86 — 89	86 — 89	..	..
1,330,000	City and South London Railway	Stock	2 %	3½%	2⅝%	49 — 52	49 — 52	51	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1½ — 2	1½ — 2	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	96 — 99	96 — 99	98	96½
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 0s.—017,139	5	Nil	Nil	..	¼ — 1½	¼ — 1½	..	..
344,923£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1¼ — 1⅜	1¼ — 1⅜	1⅜	..
81,390	Do. do. 7 % Cum. Pref., 1 to 81,390	2	..	..	..	2¼ — 3	2¼ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	8¼ — 9¼	8¼ — 9¼	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	90 — 100	94 — 99	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	12 — 13	12 — 13	12¾	12½
200,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5⅛xd	5 — 5⅛xd	5	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18½ — 19½	18 — 19	18½	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅛ — 4⅜	4⅛ — 4⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	9½ — 10½	9½ — 10½	..	..
87,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	33 — 36 xd	33 — 36 xd	..	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3⅛%	3⅛%	88 — 91	88 — 91	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations March 16th.	Closing Quotations March 23rd.	Business done week ended March 23, 1904. Highest.	Lowest.
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	⅜ — ⅞	⅜ — ⅞	..	..
50,000	Do. 7 % Pref.	1	..	..	..	1⅛ — 1⅜ xd	1⅛ — 1⅜ xd	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	115 — 118	115 —118	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	10 %	10⅛ — 10⅜	10⅛ — 10⅜	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9⅞ — 10⅛	9⅞ — 10⅛	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	106 —109	106 —109	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	8 %	7⅞ — 7⅞	7⅞ — 7⅞	..	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅞ — 5	4⅞ — 5	..	..
40,000	Do. do. 1903	5	..	..	..	4⅞ — 5	4⅞ — 5	4⅞	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	101 —103	101 —103	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	4 %	4½ %	5½%	5⅜ — 6⅛	5⅜ — 6⅛	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 %	5 %	5 %	10⅛ — 10⅜ xd	10⅛ — 10⅜ xd	10⅝	10⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14 xd	13 — 14 xd	13⅝	13½
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126	121 —126	123½	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000.	10	4 %	4 %	4 %	7⅛ — 8½	7⅛ — 8½	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000.	10	..	..	..	11 — 12	11 — 12	11¾	11½
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	106 —109	106 —109	107	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5⅜ — 6⅛	5⅜ — 6⅛	5⅞	..
80,000	Do. do. 6 % Cum. Pref.	..	..	..	..	5⅞ — 6⅛	5⅞ — 6⅛	5 15/16	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	103 —106	103 —106	105	103⅝
21,000	Kensington and Knightsbridge Electric, Ord.	5	10 %	10 %	12½	11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	103 —106	103 —106	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅛ — 1⅜	1 — 1⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	4½ — 5 xd	4½ — 5 xd	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½%	7½%	8½%	18 — 19	18 — 19	18⅝	18½
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	5 3/16	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red ..	Stock	..	..	..	95 — 98	95 — 98	96½	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
50,000	Do. do. 4 % First Mort. Debs.	100	..	..	..	99 —102	99 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14⅝	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3 — 3½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	1½%	3 %	3 — 3⅛ xd	3 — 3⅛ xd	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜ — 5	4⅜ — 5	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	12 %	13½%	12⅛ — 13⅛	12⅛ — 13⅛	13⅛	12⅜
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6⅛	6 — 6⅛	..	..

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, March 23rd.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon ..	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£23	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£37 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%) ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	205/-	..
a Sulphate of Magnesia ..	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a Crystals	per ton	£3	..
a Bichromate, casks	per lb.	2½d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£130	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£43 to £130	..
c Brass (rolled metal 2" to 12") basis	per lb.	6¾d.	..
c ,, Tube (brazed)	per lb.	8¼d.	..
c ,, ,, (solid drawn)	per lb.	7⅛d.	½d. inc.
c ,, Wire, basis	per lb.	7d.	..
c Copper Tubes (brazed)	per lb.	9½d.	½d. inc.
c ,, ,, (solid drawn) ..	per lb.	9¾d.	½d. inc.
g Copper Bars (best selected ..	per ton	£72	£2 inc.

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£72	£2 inc.
g ,, Rod	per ton	£72	£2 inc.
e ,, (Electrolytic) Bars ..	per ton	£63	..
e ,, ,, Sheets ..	per ton	£78	..
e ,, ,, Rod	per ton	£74	..
e ,, ,, H.C. Wire	per lb.	7¾d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	4/8 to 4/9	1d. inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	43/10	1/4 inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£12 7 6 to £12 10	2/6 to 5/- inc.
g ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 5	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£68	..
i ,, ,, in bars		£16 to £40	..
g Tin, Block	per ton	£131 10 to £132 10	£3 10 inc.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5⅝d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 13/16d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4⅜d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Tram. Co.	Aberdeen	Mar. 19	1,082	+257	42	50,578	+10,052	10	—
	Birmingham ..	,, 19	5,127	+ 93	11	60,912	+ 2,972	8½	—
	Bournemouth ..	,, 9	874	+ 27	50	50,525	—	10½	—
	Blackburn	,, 18	767	+ 97	—	42,432	+ 2,210	18½	—
	Blackpool	,, 17	293	— 61	50	41,063	— 394	8½	—
	,, —Fleetw'd	,, 19	181	— 22	12	2,124	— 127	7½	—
	,, —Lytham	,, 17	152	—	20	2,945	+ 2,366	7½	—
	Bolton	,, 13	1,705	+ 36	50	89,984	+ 8,928	25	—
	Bradford	,, 13	3,494	— 45	48	185,200	+22,787	78	+1
	Brighton	,, 20	722	— 54	—	44,868	—	7½	—
	Bristol	,, 18	4,603	+359	—	—	—	28	—
	Devonport ..	,, 11	448	+ 48	10	4,530	+ 707	5	—
	Dudley—Sto'rb'ge	,, 11	727	+ 10	10	7,260	+ 369	18⅝	—
	Gateshead ..	,, 11	835	+ 78	10	8,607	+ 518	10½	+ ⅜
	Gr'n'k—Pt. Glsgw	,, 11	418	+ 14	10	4,650	+ 647	7½	—
	Hartlepool ..	,, 11	231	+ 11	10	2,431	+ 278	6½	+2
	Oldham—Ashton	,, 11	468	— 57	10	4,853	— 299	8	—
	Potteries	,, 11	1,631	+151	10	16,208	+ 1,269	28⅝	—
	Southport	,, 11	223	+ 8	10	2,346	+ 234	5½	—
	South Staffs. ..	,, 11	784	+ 15	10	7,254	+ 870	21⅝	—
	Swansea	,, 11	431	— 22	10	4,567	- 161	5½	—
	Wolverhampton ..	,, 11	824	— 30	10	3,257	— 135	10½	+8
	Yorks. Wool Dist.	,, 11	480	+341	10	4,942	+ 1,478	6	—
	Miscellaneous ..	,, 11	1,994	—	10	18,264	—	—	—
Elec. Trac. Co.	Burnley	,, 19	585	+218	—	—	—	10½	+8½
	Burton-on-Trent ..	,, 20	287	—	33	11,123	—	8½	—
	Cardiff	,, 12	1,806	+130	—	96,842	+23,181	1	—
	Chatham & District	,, 17	496	+ 54	11	5,437	+ 1,015	8·58	—
	Cork	,, 17	414	— 20	11	4,234	— 98	9	—

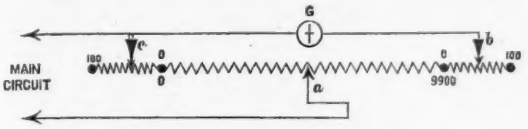
* Compared with the corresponding period of 1903.

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Dover	Mar. 19	166	— 12	11	1,862	— 140	3	—
	Dublin	,, 18	4,431	— 99	12	47,787	+ 666	47	+ ½
	East Ham	,, 19	624	+ 48	—	33,256	+ 8,780	5	+ ½
	Glasgow	,, 19	13,923	+753	42	569,665	+54,884	69½	+5½
	Halifax (2 weeks) ..	,, 9	2,096	— 69	49	64,392	+ 6,206	33	+2½
	Huddersfield ..	,, 19	1,103	+ 19	—	—	—	—	—
	Hull	,, 19	2,020	+264	51	97,528	+ 8,037	18	+2
	Ilkeston	,, 16	127	—	—	—	—	3½	—
	Ipswich	,, 19	834	—	—	5,088	—	9	—
	Isle of Thanet ..	,, 14	270	— 22	11	2,445	— 300	10½	—
	Leeds	,, 19	4,998	+135	—	274,248	+15,508	41	—
	Liverpool	,, 12	9,317	+ 6	11	103,639	+ 3,051	103	—
	London C. C. ..	,, 19	10,644	+1897	49½	498,363	+86,61*	89⅞	—
	Manchester	,, 19	10,754	+2221	—	583,990	+290,174	72	—
	Newcastle	,, 19	3,444	+864	—	—	—	17	—
	Portsmouth	,, 19	1,441	+ 48	—	86,664*	+ 5,795	14½	—
	Salford	,, 14	3,639	+649	—	189,447	+ 51,444	30	—
	Sheffield	,, 20	4,326	+129	51½	231,309	+18,249	32½	+4½
	Southampton ..	,, 17	806	— 48	—	—	—	25½	—
	Southend-on-Sea ..	,, 9	204	+ 8	49	15,002	+ 2,250	8	—
	Sunderland	,, 13	1,122	+126	50	59,675	+ 2,920	20	+3
	Tyneside	,, 16	804	+ 37	11	3,009	+ 522	8·9	+ ·43
	West Ham	,, 17	291	— 3	785	—	—	1½	—
	Wolverhampton ..	,, 20	507	+ 97	—	—	—	6½	—
	Cen. London Rly. ..	,, 19	7,062	— 80	12	84,546	+ 677	6	—
	City & S. Lon. Rly.	,, 20	2 973	— 66	12	38,250	— 594	6½	—
	Dublin—Lucan Rly.	,, 20	93	— 5	12	1,084	+ 60	6½	—
	L'pool Overh'd Rly.	,, 20	1,512	— 35	12	18,190	+ 297	6½	—
	Mersey Railway ..	,, 19	1,423	— 846	11	15,700	+ 3,708	4½	—

A UNIVERSAL SHUNT.

J. Rymer-Jones Pattern.

In the Electrical Review of April 10th, 1896, p. 467, was given an illustrated description of an adjustable universal shunt with multiplying powers from 1 to 10,000, which, when not



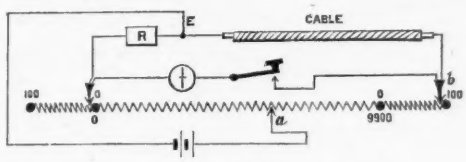
$$\text{Multiplying power of shunt} = \frac{10\,000}{n}.$$

$$\left.\begin{array}{l}\text{Resistance in galvanometer}\\ \text{circuit as shunted}\end{array}\right\} = \frac{[G + (10{,}000 - n)]\,n}{10{,}000 + G}$$

Fig. 1.—Universal Shunt.

required as a shunt, may be employed as a Wheatstone bridge, or as a potentiometer, or as slides for Gott's or Kelvin's capacity test (see annexed diagrams).

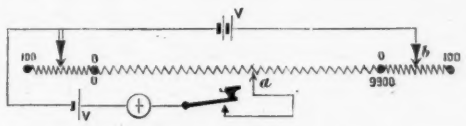
This shunt is made in the instrument department of the Silvertown Telegraph Works, where it has been employed for the last eight years, and found in every way convenient and satisfactory.



$$\text{CR of cable} = \frac{\text{R}\ 10{,}000 - n}{n}\ \text{[ohms]}.$$

Fig. 2.—Bridge Test.

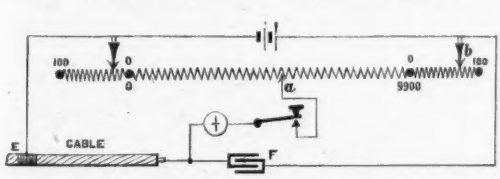
In order, however, to reduce its cost and size so that it may be suitable for use on board-ship, or in cable huts, where space is limited, Mr. J. Rymer-Jones has designed the instrument shown in the adjoining illustration.



$$\text{E.M.F. of V} = \frac{n}{10{,}000}\ \text{V}.$$

Fig. 3.—Potentiometer.

The advantages of this shunt are fewer rubbing contacts and the retention of the simple formula $\frac{G\,S}{G + S}$ for the parallel resistance* of the shunt and galvanometer resistance, instead of the complex formula and greater number of rubbing contacts of other forms of universal shunt based on the Kelvin-Varley vernier principle.

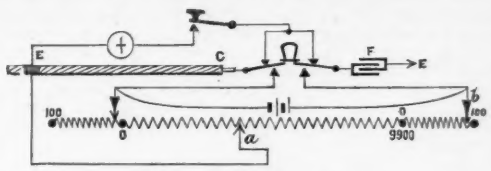


$$\text{Cable} = \text{F}\ \frac{n}{10{,}000 - n}\ \text{[mfds.]}.$$

Fig. 4.—Gott's Capacity Test.

The shunt is wholly contained in a single box measuring only 13 × 7 in., and 3½ in. deep, and is therefore very portable and easily insulated, while its cost has been reduced to one-third that of the earlier and larger form of the instrument.

No difference has been introduced into its principle. The slide resistance coils on the left-hand dial consist of 99 coils of 100 ohms each, with one sliding contact arm (*a*), while, by way of a vernier or slight alterations of the multiplying power of the shunt, there are, at both ends of these coils, other extension resistances, each extension having a total resistance of 100 ohms. These extensions have each a separate sliding contact, both being actuated by the same handle, and so disposed that when one of these contact arms press on the zero stud, the other arm is on its 100 stud. As the one contact moves from 0 towards 100 of its scale, the other moves from 100 towards 0 by equal differences of resistance.



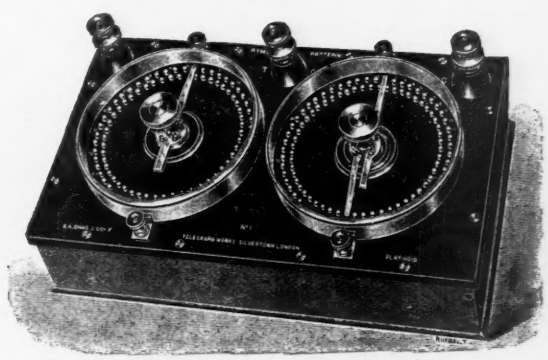
$$\text{Cable [c]} = \text{F}\ \frac{10{,}000 - n}{n}\ \text{[mfds.]}.$$

Fig. 5.—Kelvin Capacity Test.

There is, therefore, always a total resistance of 10,000 ohms between the contacts (*b*) and (*c*), between which the galvanometer terminals are connected, while (*a*) and (*c*) are in the main circuit.

The vernier resistance studs, on which the marked contact arm presses, are arranged to give consecutive multiplying powers of 2, 3, 4, 5, 6, 7, 8, 9 and 10 ten-thousandths; after which the resistances increase regularly by 2 ten-thousandths at a time. The first ten-thousandth multiplying power is left out because it is not required, and had better not be used for taking the galvanometer *constant*, for a D R test, because, even with firm and clean rubbing contacts, a small error might be introduced with so low a shunt resistance as only 1 ohm.

Thousands and *hundreds* are read off the left-hand scale at (*a*), and *tens* and *units* from the right-hand scale at (*b*). Thus, if the shunt reading be, say, 2,437, the 24 are indicated by the pointer (*a*) on the left, and 37 by the marked pointer (*b*) on the right scale. The multiplying power of the shunt is the scale readings divided



Rymer-Jones Universal Shunt.

into 10,000; *i.e.*, the reciprocal of the scale readings multiplied by 10,000; so that any multiplying power is readily obtained by inspection from Barlow's, or other book of, Tables giving the reciprocals for all numbers from 1 to 10,000. For example:—

	The reciprocal of the scale reading [*n*]	2,437	is	·0004103	× 10,000 =	4·103
Similarly.	Do.	do.	10	·1	× ,, =	1000·
	Do.	do.	50	·02	× ,, =	200·
	Do.	do.	100	·01	× ,, =	100·
	Do.	do.	500	·002	× ,, =	20·
	Do.	do.	1,000	·001	× ,, =	10·
	Do.	do.	5,000	·0002	× ,, =	2·
	Do.	do.	10,000	·0001	× ,, =	1·

In every case *n* is the full slide reading as indicated by the marked pointers, *a* and *b*, of the left and right-hand dials respectively.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME USES OF THE OSCILLOGRAPH.

On January 27th last, Messrs. D. K. Morris, associated member, and J. K. Catterson-Smith, Bowen scholar, communicated to the Birmingham Local Section the results of some observations which they had made with the oscillograph.

The first note referred to the registration of the behaviour of the magnetic cores of transformers when working on the mains. The method described is an application of the double oscillograph—that used was one of the Duddell pattern—and the device consists in passing through one of the oscillograph strips a current proportional to the magnetising force; and, through the other, a current proportional to the induction density. A parallel beam of light from an electric arc is reflected from the mirror attached to the one strip, so that the reflected beam is subject to an angular vibration proportional to the magnetising force in a horizontal plane. This re-

* Although the multiplying power of a universal shunt is not affected by the galvanometer resistance, there are occasions when certain tests require that the parallel resistance of the galvanometer and shunt employed be taken into account.

flected beam is received on one of the smaller faces of a right angle prism, placed so that its large surface is inclined at 45°. The vibrations of the beam are thus transformed into movements in a vertical plane. The light is then received on a silvered lens (acting as a concave mirror of about 18 in. radius) and focussed back on the second oscillograph mirror, so that the final reflected ray partakes of both vibrations as co-ordinates in the usual manner of B-H curves.

The no-load current of a transformer is a measure of the magnetising force applied to the core, and except for the demagnetising action of the eddy currents it measures the value of H for the iron in the core. The principle of the method employed in obtaining a current which shall be proportional to the induction density, B, is extremely simple. A large coil having no iron core, and of inductance and resistance as nearly as may be comparable with that of the transformer at no load, is placed in parallel with the transformer winding.*

Assuming r_1 and r_2 to represent the resistance of the two circuits respectively, and L_2 the inductance of the latter, then the following equation must hold at every instant:—

$$r_1 c_1 + \frac{n s}{10^8} \cdot \frac{dB}{dt} = r_2 c_2 + L_2 \frac{dc_2}{dt},$$

where n is the number of turns, and s the sectional area of the iron in the transformer core.

The first term of each side of this equation is a vector approximately at right-angles in phase to the vector representing the second term, so that if $r_1 c_1 = r_2 c_2$, then c_2 is proportional to B. Owing, however, to the irregular form of c_1, it is necessary not only to have the ohmic drops equal, but that both should be small relative to the second terms; otherwise, the curve obtained requires an irregular

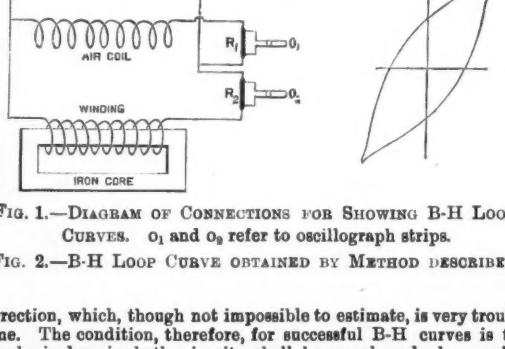


Fig. 1.—Diagram of Connections for Showing B-H Loop Curves. O_1 and O_2 refer to oscillograph strips.

Fig. 2.—B-H Loop Curve obtained by Method described.

correction, which, though not impossible to estimate, is very troublesome. The condition, therefore, for successful B-H curves is that the ohmic drop in both circuits shall be equal and also small in amount.

The method is applicable to the determination of eddy currents, for, without altering the apparatus, the same values can be obtained (taking account of the ratio of the impedance of the two circuits) from a direct current supply, and can be varied cyclically. The reduced values of H will then give at once the demagnetising action of the eddy currents. The method of superposing the vibrations of two oscillograph strips in planes at angles is also applicable to the estimation of small power factors, since a straight line can only be obtained as the resultant vibration when the two waves in these strips are exactly in phase. Any departure from this condition results in an ellipse more or less elongated.

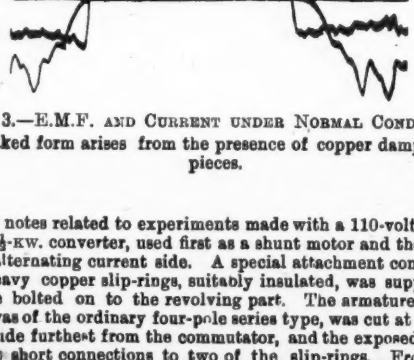


Fig. 3.—E.M.F. and Current under Normal Conditions. The peaked form arises from the presence of copper damping pole-pieces.

Other notes related to experiments made with a 110-volt Westinghouse 7½-KW. converter, used first as a shunt motor and then loaded on the alternating current side. A special attachment consisting of three heavy copper slip-rings, suitably insulated, was supported on a frame bolted on to the revolving part. The armature winding, which was of the ordinary four-pole series type, was cut at one place on the side furthest from the commutator, and the exposed ends led by stout short connections to two of the slip-rings. From one of these slip-rings a No. 26 silk-covered wire was led along the coil which had been cut, as closely as possible, threading it under the binding wire, and returning in a similar way to a third slip-ring. Thus, when the brushes on slip-rings 1 and 2 were short-circuited by a suitable low-resistance shunt, the potential across this shunt was a measure of the current flowing in one half of the armature; and the potential between the second and third slip-rings was directly proportional to the voltage in the armature coil. A Duddell oscillograph of the double high frequency pattern was arranged to measure these two potentials.

Diagrams showing the effect of shifting the brushes forwards and backwards were given, but are hardly clear enough for reproduction. These show the heavy short-circuit which occurs when the brushes are in a false position, and that heavy irregularity sets in at the same time.

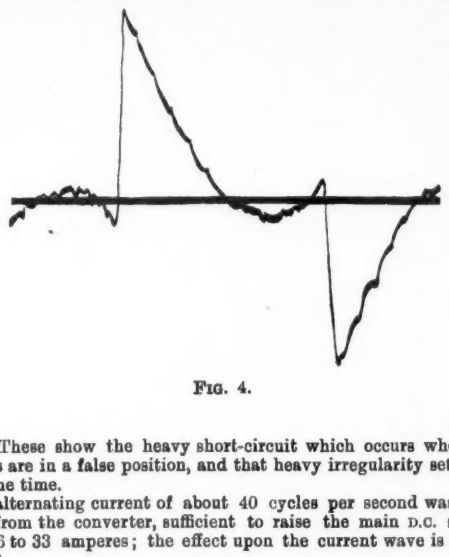


Fig. 4.

An alternating current of about 40 cycles per second was then taken from the converter, sufficient to raise the main D.C. supply from 16 to 33 amperes; the effect upon the current wave is shown in fig. 4.

The authors expressed their indebtedness to Messrs. F. B. Carmichal, A. W. Lambourne, and the departmental assistant, Mr. Bird, for their energetic assistance.

* Should the voltage be excessive, it is practicable without sensible error to transform it down, and so allow the use of a smaller coil.

THE EQUIPMENT OF AN ENGINE TEST HOUSE.

By R. K. Morcom, Associate Member.

(*Abstract of Paper read at Birmingham on February 17th*, 1904.)

A brief account of the evolution of a plant for testing combined sets for electricity stations, and of some of the more interesting results obtained, is the object of this paper.

In getting the necessary apparatus the following requirements had to be met:—

The units to be tested ranged in size from 75 to 1,250 H.P., running condensing or non-condensing, with steam pressures from 80 lbs. to 250 lbs., and degrees of superheat up to 350° F. above saturation point.

The voltage might be anything from 60 to 6,000, and the current anything from 10 to 2,000 amperes, either in direct current or in single or polyphase alternating current of various frequencies.

The sets might have to run at full load, light loads, and varying loads. Regulation tests of the dynamo and governing tests of the engine would also be generally required. Add to this the fact that only a limited space would be allotted, and as rapid changes from one set to another were necessary, the complication of the problem is obvious.

A testing plant had to be evolved to meet the above requirements, which should be accurate without being too costly, and which should be satisfactory to the expert, and yet easy to explain to the inexperienced.

Steam is raised by four water-tube boilers, capable of producing 20,000 lbs. of steam per hour. It is carried either direct to the engine or through a separately-fired superheater. Steam dryers are fitted in the flues of two of the boilers. Analyses of gases and fuel consumptions are taken periodically, and everything possible is done to keep the steam-raising costs low.

The range is designed to supply eight testing berths. It is divided into two sections, each of which can be isolated with one or more boilers in case tests at different pressures are run simultaneously.

The engines are coupled to the range by means of steel bends and matching pieces, each standard engine having its own series of piping. Flexible piping and other similar devices have been found unsuitable for test house wear and tear. The most satisfactory lagging for the temporary pipes is a large diameter asbestos rope.

Temperature Tests.—A thermometer is fitted into the steam pipe leading to each engine, and the temperature of the steam is adjusted to meet the requirements of the inspecting engineer.

Prof. Burstall suggested a platinum-wire pyrometer, but this was frequently broken by the rush of steam, and was too delicate for a works test house.

The present arrangement is a thin steel tube, screwed well into the steam pipe through a stuffing box, so that an asbestos packing may insulate it from the steam pipe. Oil is used in the tube instead of mercury, as it is found slightly more accurate; the mercury also boils away at high temperatures.

Exhaust.—Exhaust steam is passed into a range connected to three surface condensers separated by middling valves. Every branch is three-wayed, going to the engine, an atmospheric main,

and to the condenser main. The larger engines are coupled up by large cast-iron pipes, the smaller ones with flexible piping.

The air-pump discharge is passed into tanks attached to "Avery" balances, on which the amount of water delivered in any given interval is weighed and announced by electric bell to any suitable point. Before attempting to take a measurement under certain fixed conditions of load and steam, the engine should be run under those conditions for a sufficient time to ensure its having reached its proper temperature throughout. The time varies from a quarter of an hour to an hour. If this point is neglected, anomalous results are apt to be obtained Short measurements taken at different loads dropping from full load by steps down to no load at, say, 10-minutes' intervals, always give better results than when taken on an up-grade.

All cylinder drains should be closed, and the ends of the drain pipes should be inspected for leakage unless they are coupled into the engine exhaust pipe. The valve from the condensed water weigh-tank should be shut, and the sliding weight of the balance set at a fixed point on the arm. As soon as the weight is balanced, the arm on its upward swing makes an electric bell circuit, and the man at the load-board carefully notes the time and load. The slide-weight is then moved on sufficiently to give a 2-minutes' interval before the next ring, when the process is repeated. A complete log of steam pressure, temperature, &c., is taken, say, every third reading. In this way, over a half-hour's tank results can be obtained with quite as great accuracy as would be obtained by an arduous six-hours' water consumption test.

Brake Test.—Tests are often run on the water brake if the dynamo is not to hand. A series of brakes is kept to suit different sizes, the "Heenan and Froude" pattern being the one adopted. The beauty of this brake, from the inspecting engineer's standpoint, is that, whatever else it may be doing, the engine is certainly lifting a certain weight at a certain radius.

As a check on the readings, either brake or electrical, and also when comparing B.H.P. with E.H.P., the indicator is always used. But too much reliance on the readings of this instrument may lead to trouble, especially in high-speed work. Cards taken on the same load by experienced and inexperienced operators often vary as much as 5 per cent.

The indicators are continually calibrated under steam, and all cards are taken by an expert operator. An interesting point in high-speed engine indicating has been demonstrated, viz., that the oscillations always associated with the cards are actually present in the steam, and are not due to indicator inertia.

After trials of all manner of instruments, and consideration of objections raised by grumblers thereat, the following equipment for testing the electrical side of the plant has been arranged:—

Ammeters.—For direct current, shunted instruments of the "Weston" and "Solenoid" types are used. For alternating current, double-range hot-wire ammeters are adopted, except for very high voltages, when suspended-coil dynamometers have proved more serviceable. The instruments here detailed for alternating current are, of course, available for direct current also. As a calibrating instrument, a large "Siemens" dynamometer with reversing switch is found reliable.

Voltmeters.—For direct current the "Weston" type has also been chosen, being fitted with a volt-reducing box to give a very big range. For alternating work vertical scale static instruments are used. For calibration a wide-ranged horizontal scale "Kelvin" instrument has been adopted.

Wattmeters.—The hardest instrument to come to a decision about is undoubtedly a wattmeter for alternating current. The instruments finally adopted in the test-house under consideration are of the suspended coil type, both direct and zero reading.

Potentiometers.—In experimenting with a potentiometer, the fact that the works' foundations were of a light character rendered the mirror galvanometer too delicate an instrument, as the vibration of the cranes made the spot very elusive. Also it was thought best to contrive so that anyone could follow and check every figure, even the most inexperienced assistant whom it might be convenient for a chief engineer to send down.

Water Resistance.—After considerable trouble and expense in connection with wire resistances, both in wooden and iron frames, a form of water resistance for taking up the load has been devised. The poles are of iron, arranged in wooden tanks. Water from a neighbouring canal is passed continually through the tanks by a by-pass on the condenser circulating pump, and flows out over a weir. The poles are connected to a load-adjusting switchboard, and can be coupled into the load in many combinations. Three tanks are used for different ranges of voltage, and these ranges are further divided by adjustments of the outflow from the tank. Specially sub-divided tanks are used for polyphase work.

A wooden trough of small cross-section and great length was designed for high-voltage work.

Switchboards.—These are of two types. Those of the one type are purely load boards, and are placed close against the load tanks. They are arranged to give any required fraction of the load by cutting out sections of the water resistance.

The other boards are instrument boards, and are portable. They each contain a complete equipment of instruments and switches suited to the class of machine for which they are used. Special boards are provided for continuous current and high and low voltage alternating current; the latter are made suitable for three-phase work. A description of the three-phase low-voltage board will be characteristic:—

The board is made of a stout wooden frame, with an ample base which is arranged for bolting down if necessary. The instruments and switches are mounted on the front and side faces on slate slabs. In the space contained by the wings of the board at the back are arranged all the required connections and terminals. There are three hot-wire ammeters, one static voltmeter, with three-way switch, and one large three-phase switch for the main circuit. On a shelf projecting below the ammeters are placed two wattmeters of the suspended coil type. Lamps lit by the machine on test are arranged over each instrument. They serve not only to light up the dials, but afford information to a distance. The auxiliary instruments for the exciting circuit are fitted on the wings. The whole board with instruments and connections can be lifted by a crane.

The cables are laid in troughs, with a junction box to each test-berth, all being connected to the load boards.

Besides the supply of low-reading ammeters for shunt and exciting circuit reading, portable rheostats are kept, as it is generally inconvenient to run a generator with its own regulating resistance. These have two sliding contacts on the top for coarse or fine adjustment, and the coils are contained in stout angle-iron frames, shielded with perforated sheet steel. They are stronger and have a larger range than those usually supplied with the machines.

After the various trials, which can be run light, and which by deduction based on previous records, can be made to give most of the information required about the engine, the dynamo is coupled up to the load.

The portable switchboard is placed in front of the engine and connected to the dynamo and junction-box. Preliminary trials are then made, and the set made ready for the official tests, which usually comprise a six-hours' run at full load, governor trials, &c. Water consumptions are taken periodically, all necessary readings being taken while the water is being weighed. Indicator diagrams and other readings are taken simultaneously by signal.

A brief account of some recent trials will serve to show the type of results obtained in a modern test house.

Superheating.—The benefit due to superheating has long been recognised. On an engine properly designed to run under superheated steam conditions, full advantage is taken of the improved economy with but little extra trouble in running. It is only in using superheat on an engine quite unsuited for the purpose that troubles are experienced.

Another point is sometimes brought forward, that as clearance for expansion must be allowed in the pistons and valves of an engine designed for superheat, so if the superheat fail the engine will be very extravagant of fuel. Experiments have been run which prove that this is a mistaken notion. An engine designed to run with 250° superheat has been tested with dry steam at saturation temperature, and the result shows that with these valves and pistons the engine is only 2·1 per cent. less economical than when fitted with valves and pistons designed for ordinary conditions.

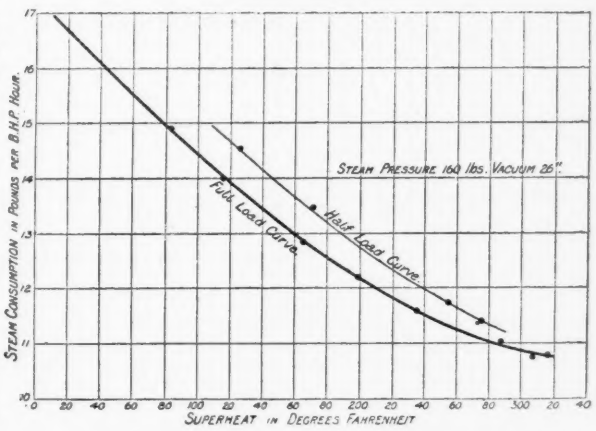


DIAGRAM SHOWING THE EFFECT OF SUPERHEAT.

Superheat water consumption curves are given in the diagram from a three-cylinder triple engine of 200-KW. capacity. Results are given at full and half loads. The trials were run on the brake at 160 lbs. steam pressure and 26 in. vacuum. It will be seen that the percentage of improvement for any given rise in temperature is approximately the same at full and half loads. The gain due to 200° of superheat is here seen to be 41 per cent. On a given type of engine the curves obtained are very similar for both large and small sizes.

The actual gain due to superheat is, of course, less than this, as extra lubrication and increased fuel consumption are required. The increased cost of oil for cylinder lubrication amounts to about 0·04d. per 100 H.P.-hour, and is therefore a very small item. Fuel consumption trials run on a 522-B.H.P. triple-expansion engine with 160 lbs. pressure and 26 in. vacuum gave the following figures:—

Trial (1).	Fuel per hour with saturated steam	...	1,193 lbs.
„ (2).	„ „ in boilers with superheat...		833 „
	„ „ in superheater to give a temperature of 600°	...	173 „

Accordingly the gain in fuel is 19 per cent. The fuel was slack of poor evaporative value.

The superheater was very lightly loaded, and the lagging of the steam pipe was not so good as it might have been. Allowing for these points, it seems that a saving of, say, 25 per cent. might be expected by superheating to 600°.

Another interesting trial taken on a 120-B.H.P. compound engine at

450 revolutions per minute was on the influence of forced lubrication on the I.H.P. at light loads. The engine was run free, and friction cards taken with oil pressures of 30 lbs., 5 lbs. and 0 lb. The I.H.P.'s in each case were 2·128, 2·409 and 3·333 respectively. This is interesting as showing that a great increase in oil pressure will not bring a correspondingly big advantage.

A testing department is always accumulating results, and curves illustrating various points are frequently made. This mass of information is necessarily largely unpublished, and the public only hear of the work of these numerous well-equipped laboratories when some improvement is put before them in a fully-fledged condition.

Discussion.

In opening the discussion, Mr. Henry Lea said:—Mr. Morcom describes the means adopted for taking the temperature of the steam passing to the engines under test, and he advocates the use of mercurial thermometers immersed in oil contained in cups made of thin steel, in preference to platinum wire pyrometers, which he says were frequently broken by the rush of steam. I suggest that if he were to enclose his platinum wire in a protecting tube having only one or two very small holes in it to allow the steam to obtain access to the platinum wire, no further trouble would ensue. My experience with mercurial thermometers immersed in cups is that they do not register correctly the full temperature of the steam. Mr. Morcom says that, in the way described, half-hour tank results can be obtained with as great accuracy as would be obtained by an arduous six hours' water consumption test. The objects of a six or eight hours' test are not confined to the measurement of condensed water, but relate generally to the behaviour of the dynamo at full load or overload, and there is no particular reason why the consumption of steam should not be ascertained over an equal length of time. The older I get, the less I feel disposed to place reliance on indicator cards. Even with the use of unusual skill, there remains the fact that the diagram is drawn with a pointed wire which makes a more or less thick line. Now if you take a rectangle 2 in. long × 1 in. high, and calculate the difference between the area of this rectangle inside and outside the thickness of the pencil line, you will find that with a line $\frac{1}{10}$th of an inch thick, the difference amounts to 3 per cent. I suppose that at the hands of some inspectors, if the contract efficiency between I.H.P. and B.H.P. were 86 per cent., and actual trial showed 83 per cent., the inspector would be inclined to condemn the plant, whereas the thickness of the line of the diagram might account for the 3 per cent. in dispute. I regard indicator diagrams as invaluable for valve setting and as a method of measurement of power where no other methods are available, but for testing steam dynamos, I should for my part be quite content to ignore the indicator diagram altogether, and take the result in lbs. of water per kilowatt-hour, the measurements of which are capable of being made with far more accuracy. I have such a great admiration for the potentiometer, that I am sorry to find that Mr. Morcom feels compelled to advocate other forms of measuring instruments for electrical purposes. When important tests are being carried out of electric generating plants costing large sums of money, a really experienced assistant should be employed, who would rejoice to find that so accurate and reliable an instrument as a potentiometer was at his disposal for measuring the results of the test. On the subject of superheating, I have made some laboratory tests, and have found that the first 40° or 50° F. of superheat account for an enormous reduction in steam consumption where the valves and pistons of the engine are at all leaky. In some of my tests 40° F. of superheat at a pressure of 60 lbs. per sq. in. reduced the amount of leakage by 45 per cent., which, to my surprise, was not materially further reduced by any increase in superheat up to 100° F. The beneficial effect of superheated steam in an engine may therefore, I conclude, be divided into two parts, namely, first, the effect of reducing the amount of steam passing through leaky valves or pistons; and second, the more economical behaviour of the superheated steam in the engine, irrespective of the amount of leakage. All engines would be benefited by about 50° F. of superheat, the more leaky ones to an extent which is almost incredible, as I proved in the case of a high-speed set of 200 H.P., which I knew was in a leaky condition, and of which the electrical output went up exactly 100 per cent. in relation to the weight of coal consumed, when the steam at the engine was superheated only from 20° to 30° F.

Mr. Holding said that while Weston instruments of the standard horizontal type were about the best that were to be got, he had never found more than one or two that could be trusted for a week without re-calibration. With regard to wattmeters he found the Kelvin balance very good, and generally trusted by inspectors. Both the Kelvin and Swinburne instruments suffered to some extent from the fact that they were not direct reading. A direct reading wattmeter which did not require a spring to be moved or weight lifted, would be a very great convenience. Potentiometers were valuable instruments, but they required to be in very good hands. His experience of inspectors sent by consulting engineers corresponded with that of Mr. Morcom. In many cases the inspection was almost a farce.

Mr. Reynolds said: At the test-house of Willans & Robinson, Rugby, they had very much the same sort of apparatus for connecting up the steam ranges as Mr. Morcom had described. Flexible pipes were quite out of the question, as they would not stand the wear of a test-house. Their instruments were fixed, and there were permanent leads coming down to pillars near every machine, so that the only thing they had to do when a machine came on the bed was to connect up the leads on the pillars. In the same way they had permanent leads for the load. With regard to the condensers, they had found there was a large loss of vacuum whenever they had a bend or an angle in the pipe. With condensers fixed, it seemed to him they must have rather a low vacuum; and, if so, what allowance did they make to get the guarantees of 28 and 27 in. vacuum? As to the indicating, if the operator was experienced, and the indicators were kept with all their joints in working order, he thought the I.H.P. was well within ½ per cent. of what it ought to be. He quite agreed with what had been said about the engineers who came down to inspect sets. In the works of which he had experience they found water resistance did not keep the load so steady as their ordinary resistance. They had coils of wire, and also ordinary galvanised lattice wire, which they found a very good, steady resistance. They had found that engines did not require to be designed for superheat at all. They put superheat on their standard type of engines, and they had never had any difficulty; and when they went back to the saturated steam they did not find any reduction in the steam consumption. No extra lubrication was required with superheat. That very afternoon he was running an engine at about 200° F. superheat, and somebody suddenly discovered that the sight-feed lubricator had not been working for about a couple of hours, but the engine had not seized. They had found a very similar curve to that shown by Mr. Morcom in their trials at Rugby. They had found with full, three-quarter, half and quarter load that as the superheat went up the consumption tended to become the same at each. In fact, with a fairly high degree of superheat, they had found the water per H.P. to be very much the same as with variable cut-off.

Mr. Walsh, endorsing what had been said as to the difficulty experienced at Messrs. Belliss & Morcom's works with the platinum wire pyrometer, said they put a perforated plate round the arrangement that carried the wires, but it did not seem to help matters much. As had been emphasised, an inspector must take the instruments for granted. There was always this about the Weston ammeters—they were calibrated from an independent source; they were generally supplied sealed up with their shunts, and if there was any question at all about the ammeter readings, the instruments could be taken away and calibrated by the Board of Trade. The weighing tanks were very easily checked by standard weights. They had a series of standard weights so that inspectors might check the arrangement at the beginning and the end of the run. Of course the indicator might give a very thick line, but the expert sharpened his pencil. You could get a line very much narrower than the hundredth part of an inch.

Mr. Ashlyn said his experience had been that it was very difficult to get two ammeters to read alike. He would like to ask whether Mr. Morcom found the shunts themselves varied in actual use. If they worked water consumption out to a decimal point, they needed to be equally careful not only in their steam readings, but also in their electrical readings.

Mr. Morcom, in reply, said that it was unnecessary to waste the time of the staff in lengthy measurements of water consumption. When he said the indicator was used to compare B.H.P. with E.H.P., he meant B.H.P., and not I.H.P. They ran the engine on the dynamo, then took the generator off, and put on the brake, and in that way they found the actual efficiency of the generator. The tank 4 ft. wide × 10 ft. long, and 4 ft. deep, took 500 volts and 2,000 amperes with a steady flow of canal water, which had a very high conductivity. With regard to superheat, he did not think the excessive gains over the early ranges which were mentioned, would be found with engines having carefully designed piston and valve rings. They found the Weston ammeters were not only very convenient, but also extremely accurate, and they stayed so. The hot-wire ammeters they used were Johnson & Phillips'. They had fixed instruments with permanent connections at Belliss & Morcom's works once, but gave it up because they found it so much more convenient to have the instruments reasonably close to the engines under test. As to loss of vacuum, they did not need to make any allowance for it, as they gave their guarantees without it. The Siemens dynamometer which they used was large and enclosed in glass, and its readings had shown great accuracy, well within 1 per cent. over a long period. The figure he had given as to fuel gain by superheat, was taken fairly recently on a trial, and they had had a check on it which bore out the estimate of 25 per cent.

VARIABLE SPEED MOTORS.

By J. W. BURLEIGH.

The object of this article is not to enumerate the advantages of motors which are capable of withstanding large variations of speed by inserting a resistance in shunt, but rather to show the method of design adopted by the writer to attain this end. With present day knowledge of continuous current motors, it is not an exceedingly difficult matter to design a machine to run at a certain definite speed, with a moderate temperature rise, and sparkless commutation, combined with high efficiency and comparatively cheap production. With motors, however, having a large range of speed, the conditions quoted are not nearly so easily attained. In a machine which is required to run at three or four times above lowest speed, the chief problem which besets the designer is to economically produce it so that the brushes have a fixed position for any speed within the range specified.

In the writer's opinion the first and foremost question to be considered in a variable speed motor is its commutating properties; to get good results in this direction it is highly important to render the self-induction, due to the short-circuited coils, as low as possible, also at the lowest speed to make use of a much higher density in gap than usually found in constant speed motors.

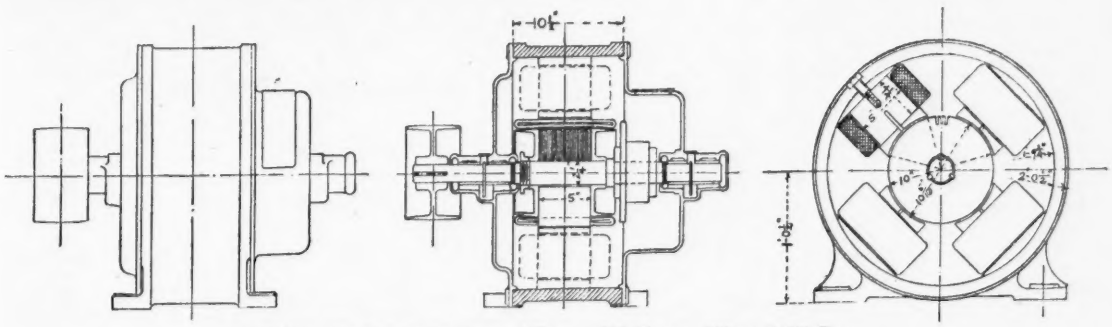
From the writer's experience he finds that to obtain the best results the reactance volts at maximum speed should not exceed 2·5, and the ampere-turns per pole should never be less than the ampere-turns required for gap.

As regards the type of machine best adapted for motors of this description, this depends somewhat on the output, but to get the best all-round results for motors up to about 20 H.P., designers are usually in favour of a four-pole machine with series wound armature and four sets of brushes.

Constructed on good lines, the variable speed motor seems to be well adapted for an enclosed machine, the reason of this is that, generally speaking, there is a comparatively larger radiating surface than in a constant speed motor for the same specific output. If the losses were increased in proportion to the extra sizes required, the efficiency would, of course, be considerably lower than in a constant speed motor.

Density teeth	23·9
,, armature	10·0
,, gap	10·53
,, field (v. 1·18)	16·8
,, yoke (v. 1·18)	14·55
Amp.-turns, teeth	340
,, ,, armature	40
,, ,, gap	3,100
,, ,, field	380
,, ,, yoke	280
Total amp.-turns per pole	4,140
Length of coil	4 in.
Size of wire	17 B.W.G.
No. layers	25
Turns per layer	56
,, ,, coil	1,400
Total turns	5,600
Depth of winding	1·8 in.
Mean length of turn	22·5 in.
Yards	3,500
Resistance cold	32·2 ω
,, warm	36 ω
Shunt current	3·06 α
Ampere-turns per coil	4,280
Watts lost in shunt	837
Weight of copper per coil	27 lbs.

parking factors at lowest speed—400 revs.—	
Revs. per second	6·65
Diameter of commutator	5¾ in.
Width of brush	·625 in.
~ commutation	96
Bar and insulation	·235 in.
No sections short-circuited	3
Turns per section	3
Inductance	·000059
Current per conductor	16·5 α
Reactance volts	·59
Armature ampere-turns per pole	950
Gap ampere-turns / armature ampere-turns	3·27
Sparking factors at highest speed—1,200 revs.—	
Revs. per second	20
~ commutation	288
Inductance	·000059
Current per conductor	16·5 α
Reactance volts	1·77
Armature a/s per pole	950
Density in gap	3·51
Ampere-turns gap	1,030
Gap ampere-turns / Armature ampere-turns	1·09



General Arrangement, 4-B.H.P. Motor, 110 Volts, 400 to 1,200 Revs.

In the following calculations Kapp lines are used and inch measurements except where otherwise stated :—

4-H.P. Motor.

Rated B.H.P.	4
Speed (minimum)	400
Voltage of supply	110
Number of poles	4
Diameter of armature	10 in.
Length of ,,	5 in.
Effective length	4·5 in.
Number of slots	77
Depth of slot	·78
Width of ,,	·17
Width tooth at bottom	·178
Polar angle	66°
Number teeth under pole + 10% for fringing	14·15
Effective area of teeth at bottom	11·3 sq. in.
Diameter of armature at bottom of slots	8·54 in.
Internal diameter	2½ in.
Area of armature	27·2 sq. in.
Diameter of bore	10·3125 in.
Length pole arc	5·42 in.
Area of pole	27·1 sq. in.
Effective area of pole, say 95 % actual area	25·7 sq. in.
Area field magnets, average	19 sq. in.
Area of yoke × 2	22 sq. in.
Type of winding	Series.
No. conductors per slot	6
Size of conductor	18 S.W.G.
Total number of conductors	462
Area conductors in one slot	·0899 sq. in.
Area of slot	·124
Space factor	·331
Mean length of turn	29 in.
Resistance of armature wound	·193 ω
Current in armature	33 α
Volts lost in ,,	6·4
Number sets of brushes	4
,, brushes per set	1
Size of brush	1½ × ⅝ in.
Area of ,,	·702 sq. in.
Current density per sq. in.	23·5 α
Diameter of commutator	5⅝ in.
Peripheral speed feet per minute	601
Area + brushes	1·404
Resistance of contact	·0426 ω
Volts lost due to brush contact	1·4
Watts lost due to friction of brushes	15
Internal volts, say	100
Flux per pole	271
Density in armature Kapp lines (per inch)	10
Density in armature C.G.S. lines (sq. cm.)	9,300
~ per second	13·35
Weight of core and teeth in kilogrammes	37
~ per sec. × kilos. sq. cm. / 100	1·24
Watts per kilogramme due eddy currents hysterisis	3·2
Total watts lost in core and teeth	118

6-H.P. Motor.

Rated B.H.P.	6
Speed (minimum)	300
Voltage of supply	220
Number of poles	4
Diameter of armature	11⅜ in.
Length of ,,	6½ in.
Effective length	5·62 in.
Number of slots	45
Depth of slot	·94 in.
Width of ,,	·29 in.
Width tooth at bottom	·375 in.
Polar angle	62°
Number teeth under pole + 10% for fringing	8·5
Effective area of teeth at bottom	17·9 sq. in.
Diameter of armature at bottom of slots	9·515 in.
Internal diameter	2¾ in.
Area of armature	38 sq. in.
Diameter of bore	11⅜ in.
Length of pole arc	6·37 in.
Area of pole	39·8 sq. in.
Effective area, say ·95 of actual area	37·8 sq. in.
Area of field-magnets	30 sq. in.
Area of yoke × 2	34·5 sq. in.
Type of winding	Series
Number of conductors per slot	18
Size of conductor	14 S.W.G.
Total number of conductors	810
Area conductors in one slot	·0905 sq. in.
Area of slot	·269 sq. in.
Space factor	·336
Mean length of turn	33½ in.
Resistance of armature, warm	·52 ω
Current in armature	23 α
Volts lost in ,,	12
Number sets of brushes	4
,, brushes per set	1
Size of brush	·875″ × ·625″
Area of brush	·547 sq. in.
Current density per sq. in.	21 α
Diameter of commutator	7½ in.
Peripheral speed feet per minute	590 ft.
Area + brushes	1·09 sq. in.
Resistance of contact	·055
Volts lost due to brush contact	1·3
Watts lost due to friction of brushes	11
Internal volts, say	203
Flux per pole	417
Density in armature Kapp lines (per sq. in.)	11·0
Density in armature C.G.S. lines (per sq. cm.)	10,240
~ per second	10
Weight of core and teeth in kilogrammes	60
~ per sec. × kilos. sq. cm. / 100	1·024
Watts per kilogramme due to eddy currents and hysteresis	2·8
Total watts lost in core and teeth	168

Density teeth	23·3
,, armature	11·0
,, gap	11·0
,, field v. 1·18	16·4
,, yoke v. 1·18	14·3
Amp.-turns teeth	200
,, ,, armature	60
,, ,, gap	3,890
,, ,, field	400
,, ,, yoke	320
Total amp.-turns per pole	4,970
Length of coil	5 in.
Size of wire	18 B.W.G.
No. of layers	29
Turns per lay	80
,, ,, coil	2,320
Total turns	9,280
Depth of winding	1·83 in.
Mean length of turn	26·5 in.
Yards	6,750
Resistance cold	87 ω
,, warm	100 ω
Shunt current	2·2 α
Ampere-turns per coil	5,100
Watts lost in shunt	484
Weight of cu. per coil	37 lbs.

Sparking factors at lowest speed—300 revs.—	
Revs. per second	5
Diameter of commutator	7½ in.
Width of brush	·625
~ commutation	94·5
Bar and insulation	·175 in.
No sections short-circuited	4
Turns per section	3
Inductance	·000097
Current per conductor	11·5 α
Reactance volts	·663
Armature ampere-turns per pole	1,165
Gap ampere-turns / Armature ampere-turns	3·34
Sparking factors at highest speed—900 revs.	
Revs. per second	15
~ commutation	284
Inductance	·000097
Current per conductor	11·5 α
Reactance volts	1·98
Armature ampere-turns per pole	1,165
Density in gap	3·67
Ampere-turns gap	1,295
Gap ampere-turns / Armature ampere-turns	1·11

EARTH CONNECTIONS.

By W. MOON.

(*Concluded from page* 486.)

If the resistance of the battery is small as compared with the other resistances of the circuit, and the arms A and B of the bridge are equal, and E is the E.M.F. of the battery, and e that of the earth connections, and L the resistance of the line and earth connections, then

$$\frac{E}{A + R_1} = \frac{E - e}{A + L}, \text{ also } \frac{E}{A + R_2} = \frac{E + e}{A + L} \quad (8)$$

$$\therefore E(A + L) = (E - e)(A + R_1) = (E + e)(A + R_2) \quad (9)$$

from which

$$e = E \frac{R_1 - R_2}{2A + R_1 + R_2}. \quad (10)$$

This gives the value of the difference of the E.M.Fs. at the two earth connections.

Also from (9)

$$e = E\left(1 - \frac{A + L}{A + R_1}\right) = E\left(\frac{A + L}{A + R_2} - 1\right)$$

$$\therefore L = \frac{R_1 + R_2}{2} - \frac{(R_1 - R_2)^2}{2(2A + R_1 + R_2)}. \quad (11)$$

On any circuit where the values of E, e and L are known, the values of R_1 and R_2 with different values of A can be calculated. From (8)

$$R_1 = \frac{E}{E - e}(A + L) - A$$

$$R_2 = \frac{E}{E + e}(A + L) - A.$$

From these last two equations it will seen that R_1 and R_2 become more unequal as e and A are greater as compared with E and L, and also that R_1 increases at a more rapid rate than R_2 decreases. And from this it is evident that the correction $\frac{(R_1 - R_2)^2}{2(2A + R_1 + R_2)}$ to the ordinary formula $\frac{R_1 + R_2}{2}$ becomes greater, the greater the values of e and A. To make this correction as small as possible, E should be made great to e, and A should be taken as small as possible.

As an example, suppose $R_1 = 300$, $R_2 = 200$, and $A = 1{,}000$; then $L = 250 - 2 = 248$ and $e = E\,\frac{1}{25}$. Taking $E = 25$, then from these values of e and L it will be found that if A had been 100, R_1 would have been 262·5 and R_2 234·5, and the correction to L would have been only about half an ohm. And, again, if A had been 10, the correction to L would have been only a third of an ohm.

The correction to the ordinary formula $\frac{R_1 + R_2}{2}$ is unimportant, unless R_1 and R_2 differ greatly.

When a continuous current is applied to an earth connection, an opposing E.M.F. is generated which is greater in amount, rises more rapidly to its maximum, and afterwards falls more slowly to zero, as the current applied is denser.

The relation between the applied current and this opposing E.M.F. cannot be readily expressed by a formula. If the density of the current were great enough, a maximum opposing E.M.F. equal to that of the decomposition of water would be obtained, and any increase in the current would not lead to any further increase in the opposing E.M.F.

The opposing E.M.Fs. generated in different samples of clays, sands and gravels, differ in amount, but not in so marked a degree as their resistances. There is, moreover, no relation between the resistances of these earths and the opposing E.M.Fs. generated in them. Some of the sands and gravels have a greater opposing E.M.F., and some a less than the clays, amongst which, also, the opposing E.M.Fs. were not uniform. But the opposing E.M.Fs. with different soils did not differ more than 15 per cent. from the mean value.

With a current of 5·5 milliamperes per square decimetre, this mean value was about ·34 volt maximum E.M.F., and about 25 minutes elapsed before three-quarters of the maximum E.M.F. was reached. After cutting off the current, the E.M.F. fell to half its maximum in 1 hour and 20 minutes, and to a quarter of its maximum in 5 hours 40 minutes, the circuit being disconnected after the cutting off of the current. With a current of 1 milliampere per square decimetre, a mean maximum E.M.F. of ·12 volt was obtained and about 45 minutes elapsed before three-quarters of the maximum E.M.F. was reached.

The presence of impure water at the earth plates increases the polarisation.

A sample of sand taken about 2 miles from the seashore had a maximum polarisation of ·47 volt with 5·5 milliamperes per square decimetre, and ·18 volt with 1 milliampere per square decimetre.

As soils of either sand, gravel or clay, offer a less surface of contact to an earth plate as they become drier, the polarisation as well as the resistance is increased.

If any soil has a current sent through it for some time, and the direction of the current is then reversed for a shorter time and finally cut off, it will be found that after the polarisation due to the second current has disappeared, the E.M.F. will be reversed, and the effects of the polarisation due to the first current will reappear.

If the testing current generates an opposing E.M.F. of e, and the arms A and B of the bridge are equal,

$$\frac{E}{A + R} = \frac{E - e}{A + L}$$

$$\therefore L = R - \frac{e}{E}(A + R). \quad (12)$$

$\frac{e}{E}(A + R)$, the correction to R, is greater the greater e and A are; therefore, this correction, as well as that in (11), is made small by making E as great and A as small as possible.

If the value of e were known, L could be corrected by formula (12), and, if necessary, again corrected by formula (11).

Since e is dependent upon the density of the current, and is constant with a constant current if the current is applied long enough, it would appear from (12) that by taking two measurements with a constant current and two different values of E and A, e could be eliminated. But in practice such an operation would be tedious and the result uncertain; and yet the error introduced by the polarisation produced by the testing current is more considerable than that due to the steady E.M.F. of formula (11). If, for instance, $e = \frac{1}{10}$, $E = 10$ and $R = 200$, then with $A = 1{,}000$, the correction would be 12, with $A = 100$ it would be 3, and with $A = 10$ it would be 2·1.

The resistance of an earth connection is of greater importance on a short than on a long circuit, and where the resistance of a circuit is measured with the object of calculating the power required to produce a certain current, the resistance, or rather the apparent resistance of the circuit, should be measured with the current strength that is to be used for working the circuit.

To determine the resistance of one of the earth connections of a circuit apart from the other, the presence of a second circuit is required, or, failing a second circuit, an auxiliary plate may be sunk at some distance from the earth connection to be measured.

If l_1 and l_2 are the resistances of the two lines together with their distant earth connections, and ρ the resistance of the earth connection to be measured, then, with the Wheatstone bridge, six different measurements of combinations of two of these three values may be made.

$$l_1 + \rho = a$$
$$l_2 + \rho = b$$
$$l_1 + l_2 = c$$
$$l_1 - l_2 = d$$
$$l_1 - \rho = e$$
$$l_2 - \rho = f$$

and from these six measurements, 10 equations from which ρ can be determined are obtained—

$$\rho = \frac{a + b - c}{2}. \quad (13)$$

$$\rho = \frac{c - e - f}{2},$$

$$\rho = \frac{a - f - d}{2},$$

$$\rho = \frac{d + b - e}{2},$$

$$\rho = \frac{a - e}{2},$$

$$\rho = \frac{b - f}{2}.$$

$$\rho = a - \frac{c + d}{2}. \qquad (14)$$

$$\rho = b - \frac{c - d}{2}. \qquad (15)$$

$$\rho = \frac{c + d}{2} - e,$$

$$\rho = \frac{c - d}{2} - f.$$

In making any of the measurements a, b, c, d, e, f, it is necessary to keep the testing current of the same strength, and therefore, the E.M.F. of the testing battery should be proportional to l_1 and l_2 in measuring a and b and to $l_1 + l_2$ in measuring c. In measuring d it should be proportional to the longest line l_1, and in measuring e to $\frac{2\,l_2 + l_1}{l_1}$ and $f = \frac{2\,l_1 + l_2}{l_2}$, so that to measure e and the battery power should be increased about three times if the lines are of about equal resistance. For this reason the measurements a, b, c and d are to be preferred to e and f. And equations (13), (14) and (15) are the best with which to measure the resistance of an earth connection.

By making four measurements, two values of ρ are obtained by (14) and (15) that check each other and should agree.

The effect of not increasing the battery power when measuring c, is to get a value of ρ smaller than it should be.

It is needless to mention that before filling in the values of a, b, c and d in (14) and (15), they should be corrected for the E.M.F. at the earth connections by (11) and (12).

The following example shows how important these corrections for E.M.F. are :—Two earth plates were sunk 40 ft. apart, and the resistance of the circuit tested with 10 volts gave :—

z 40, c 14 } 27^{ω} with $1{,}000^{\omega}$ in the arms A and B of the bridge,

z 22, c 18 } 20^{ω} with 100^{ω} in the arms A and B of the bridge,

z 17, c 15 } 16^{ω} with 10^{ω} in the arms A and B of the bridge.

The true resistance between these plates would be about 15^{ω}. If instead of being close together they had been at the ends of a block signal circuit, the apparent resistance would have been 17^{ω}, and if they had been at the ends of a long telegraph circuit, the apparent resistance would have been 22^{ω}.

THE DIESEL ENGINE.

We have received from the Diesel Engine Co. copies of various pamphlets relative to their engine, of which there are now a fair number at work in this country. In its more modern form, this engine has arrived at a very good shape. It is very strongly built, and exhibits no sign whatever of the extraordinarily high pressures that are working within it. It is very completely water-jacketed, and this makes it a very comfortable engine to live with and to indicate. The largest engines so far made are, we believe, two 80-B.H.P. engines. We have seen such an engine at work on a traction load, and its performances were very good, the engine running well and steadily.

The engine differs from ordinary oil engines in that it uses heavy or crude petroleums at a comparatively low price, and its output in kilowatts is effected at a cheap rate. From 0·3 to 0·33 lb. of oil per B.H.P.-hour will be consumed at about three-quarter load and above. Per B.H.P., the thermal capacity of a Diesel engine will be as high as 30 per cent. Thus about 30 per cent. appears as outside work, 30 per cent. as jacket-water heat, and 30 per cent. in the exhaust gases, the remaining 10 per cent. going into friction, a large part of which is at the fly-wheel bearings, for the fly-wheel must be inversely heavy, as the working strokes are few, and the engine works on the Otto cycle, and must, therefore, lose more in friction than does a double-acting steam engine. The actual friction as a machine is, however, by no means high, for the mechanical efficiency of a four-cycle engine is fully 75 per cent. at normal load. Of course, at very small loads, the friction forms a large proportion of the total load, but any good results will be obtained even on a traction load where the mean load is even less than two-thirds.

The engine is very easy to start, provided, of course, that the high pressure air reservoirs are kept properly charged. When an engine is sent out from the works, its cylinders of compressed air go with it, and they provide the first start. In starting, the oil valve combustion is put out of gear, and the engine is run for a few revolutions by compressed air. A simple movement of the special lever through 90° puts the engine into normal working order to run on oil, and it simply continues to run, and the air reservoir is pumped up full every time. The oil fuel is sprayed into the cylinder by aid of the high pressure air which must, of course, be at a higher pressure than the compression in the cylinder, viz., 500 lbs. per sq. in.

The principle of the engine differs from that of all other internal combustion engines. In the Diesel engine, pure air is compressed up to about 35 atmospheres, or, say, 500 lbs. In this sudden and heavy compression heat is generated, and the air acquires a temperature of probably 1,000° F., or nearly so. The temperature is at least the ignition temperature of the oil fuel, and the fuel is only sprayed into the compressed charge of air at the proper time. It burns quietly in the hot air, as the piston moves forward, and simply expands the air without increasing its pressure, the expansion of the gas being along a curve on the diagram, merely so much displaced laterally from the curve of compression. Thus the combustion is converted very directly into work, and per unit of work actually performed, *i.e.*, per I.H.P., a thermal efficiency of over 40 per cent. has been attained. At 0·44 of a lb. of oil per B.H.P., the cost of power is only about 0·12d. per B.H.P.-hour with oil at 50s. per ton, or 0·14d. per KW.-hour, allowing for a generator efficiency of 92 per cent.

The economy comes in largely in the saving of a stoker, of ash cartage, and other expenses inseparable from a steam plant of small size. Tests of Diesel engines have been made in this country by Mr. Ade Clark, who also made other tests in Belgium; by Mr Wilkinson and by Mr. W. H. Booth, and we understand that such tests made by different observers on different engines have given very conformable results. The engine is thus certain in action, and the principle on which it works is proved good. The ordinary gas engine, or internal explosion engine, began life as a simple atmospheric pressure engine. Then it acquired compression, and attained to its present-day condition and status. The Diesel engine started off originally as a thought out engine, and it was hoped to have avoided the loss due to jacketing, and to have made an engine conforming approximately to scientific views. But limits were put upon a full acceptance and carrying out of such views in practice by the very nature of the materials of construction that are available, and the Diesel engine of to-day is very fully water-jacketed, and loses to the jacket, as do other internal combustion engines, a large percentage of the total heat of the fuel employed.

Seeing that modern tool steels are capable of working and of retaining strength at a red heat, is it too much to hope for an extension of temperature tolerance on the part of some future cylinder metal, so that water jackets may yet be abolished? Were this possible, the thermal efficiency of an engine might be raised to even 60 per cent. on the I.H.P., or 45 per cent. on the B.H.P. An engine of 80 B.H.P. on the Diesel principle at present has a cylinder 400 mm. diameter by 600 mm. stroke, and it runs at 160 r.p.m.

THE RIGHT TO OPPOSE A PRIVATE BILL.

A report of the proceedings before the Court of Referees in relation to the St. Marylebone Electric Lighting Bill, which we published on page 413, naturally turns attention to the question how far it is competent for an interested party to appear in opposition to a private Bill before a Parliamentary Committee. In the case in question, the St. Marylebone Borough Council have promoted a Bill to enable them to raise by loan a sum of £1,812,000. Of this sum £1,212,000 is to be devoted to discharging a judgment debt which is due to the Metropolitan Electric Supply Co., Ltd., in respect of the sale by them of so much of their undertaking as lies within the Borough of St. Marylebone. The company sought leave to appear in opposition to the measure on the ground that the Council were asking for £600,000 in addition to the debt due to the company, and it was feared that if this further loan were sanctioned, it might have given priority over the debt due to the company. After some discussion, the Court of Referees disallowed the *locus standi* of the company.

It may be of interest to discuss some of the principles which guide the Court of Referees in determining a question of this kind. It is obvious that if every person who fancied he had a grievance were permitted to oppose a Bill, the proceedings before Private Bill Committees might be indefinitely protracted. Hence the Court of Referees have consistently acted on certain rules—ill-defined, perhaps, but, nevertheless, rules which enable them to decide whether to allow the *locus standi* of any person who may petition against a Bill.

It may be stated generally that if one company already had a provisional order for the supply of electric light in a district, it would be allowed to appear by counsel before the Parliamentary Committee, and oppose the grant of a second provisional order. So the local authority who supply electricity would be heard in opposition to a private company who were applying for a Bill. It will be seen that the Committees are ready to hear anyone who fears that his interests may suffer in consequence of the Bill being passed, and it is for this reason that we are surprised at the decision of the Court of Referees with regard to the *locus standi* of the Metropolitan Electric Supply Co. As it seems to us, they have the very deepest interest in the grant of any loan to the St. Marylebone Borough Council. Seeing that this body is already under statutory liability to the company, having regard to the fact that local loans are not easy to place upon the market, it is a matter for grave doubt whether Parliament will permit a stupendous loan, and it is but common justice to the company that they should have the first call upon any fresh funds which may be raised.

If we glance at the Parliamentary procedure in respect of certain other undertakings, the decision of the Court of Referees becomes even less easy to understand. Take the case of a water company. Sec. 30 of the Tramways Act provides that in laying down a tramway, the undertakers must make full compensation for any loss or interference with water pipes. It was held for some time that Sec. 30 provided sufficient protection both for gas and water companies, and that they were not entitled to a *locus standi* for the purpose of obtaining further protection (Lea Bridge, &c., Tramways Bill, 1881, 3 Cl. and R. 72), though in one case a very limited *locus standi* was granted to a water company by consent. This doctrine has been considerably modified. Soon after the above cases a *locus* was granted to two water companies, against a clause authorising certain widenings on the ground that it was doubtful whether Sec. 30 afforded sufficient protection in such cases (Brentford and District Tramways Bill (1885) R. and M. 6); a *locus* was allowed to water and gas companies against a clause authorising cable haulage, because such a mode of propulsion was not contemplated when Sec. 30 was enacted. Again, omnibus proprietors are allowed a *locus standi* against tramway Bills, on the ground of competition, and they are also conceded a *locus* against a Bill which has for its object the conversion of horse tramways into electric tramways, on the ground that competition may be thereby increased. The right to be heard in opposition is not, however, confined to questions of competition. Thus, a railway company will have the right to be heard against a proposed line over one of their bridges. They must, however, allege such injury, or the probability of it.

A Bill introduced by a local authority is supposed to be introduced with the consent and sanction of the ratepayers who are represented by the authority, and hence no ratepayer is conceded a general *locus* to oppose the measure. But if he can show that as a frontager or occupier of a house he is affected in the use or enjoyment of his premises or in the conduct of his trade or business, he may then appear and oppose. So a frontager upon the route of a suggested tramway would be allowed to oppose the erection of so much of the line as lay in front of his house. This does not mean, of course, that his opposition would of necessity be successful. It would merely give him the right to be heard. This being the law, it is difficult to understand why the Court of Referees did not see their way to concede a *locus standi* to the Metropolitan Electric Supply Co., whose interests are so nearly affected by any financial proposal of the St. Marylebone Borough Council.

NEW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

5,519. "Improvements in flexible continuous covering for the ploughway of electric conduit system and apparatus on cars for manipulating the said covering." T. T. Dewhirst and J. Gurney. March 7th.

5,532. "Improvements in sparking plugs for internal combustion engines." A. D. Sedger, Jun. March 7th.

5,560. "Improvements in coils for electrical machines." I. De Kaiser. (Date applied for under Patents Act, 1901, May 1st, 1903, being date of application in United States.) March 7th. (Complete.)

5,566. "Improvements in joints or connections for wires or conductors of electrical energy for telephonic and other uses, and in apparatus employed therein." W. Heatley. March 7th.

5,582. "Improvements in connection with electrostatic wattmeters or watt-hour meters." E. Wilson. March 7th.

5,596. "Improvements in, or relating to, telegraphic apparatus." F. G. Creed and W. A. Coulson. March 7th.

5,620. "Improvements in junction boxes for electric wiring." F. Muirhead. March 8th.

5,630. "Improvements in gas or electrical fittings." J. Solari. March 8th.

5,634. "Improved switch point and 'frog' for the overhead equipment of electrical traction." J. Bonthrone. March 8th.

5,646. "Improvements in electric and other lamps." R. Böhm. March 8th.

5,649. "An improvement in plating aluminium or its alloys with a metal or metallic alloy by electrolysis." R. B. Wheatley. March 8th.

5,668. "Annunicators for electric bells and the like." H. Henning. March 8th. (Complete.)

5,670. "Improvements in holders for electric incandescent lamps." E. B. Skinner. March 8th.

5,678. "Improvements relating to electric conductors or cables." S. G. Brown. March 8th.

5,688. "Improvements in apparatus for producing reactions in gases by means of electricity." J. Y. Johnson. (Badische, Anilin & Soda Fabrik, Germany.) March 8th.

5,714. "Improvements in fittings of electroliers, wall brackets, and the like used in electric wiring." A. H. Wheeler. (F. A. Wheeler, Natal.) March 8th.

5,731. "Improvements in electrical regulating devices applicable to clocks." F. W. Howorth. (Actien-gesellschaft "Magneta" Eletrische Uhren ohne Batterie und ohne Contacte, Switzerland.) March 8th.

5,768. "Improved automatic cut-out for electric trolley wires and the like." J. Woodward. March 9th.

5,778. "Improvements in plough or collector gears for electric conduit tramways." P. T. J. Estler. March 9th.

5,786. "Improvements in and relating to luminous gas or vapour electric lamps." The British Thomson-Houston Co., Ltd., and E. Schattner. March 9th.

5,799. "Improved electrical apparatus for separating coke from cinders and other substances." H. Lelarge. March 9th. (Complete.)

5,804. "Improvements in and relating to the electrical firing apparatus for internal combustion explosion engines" K. J. McMullen. March 9th.

5,824. "An improved electric igniter for explosion motors." H. Luthi. March 9th. (Complete.)

5,826. "Improvements in electric arc lamps." W. J. Davy. March 9th.

5,861. "Improved insulating linings for covers or containers for electrical apparatus." C. M. Dorman and R. A. Smith. March 10th. (Complete.)

5,914. "An electric pocket lamp, cigar, cigarette and gas-lighter combined." S. Kraus. March 10th. (Complete.)

5,921. "Improvements in electric melting furnaces." La Societe Anonyme L'Industrie Verriere et ses Derives. March 12th. (Date applied for under Patents Act, 1901, March 21st, 1903, being date of application in Belgium.) (Complete.)

5,926. "Improvements in and relating to electric motors." Mavor & Coulson, Ltd., and H. A. Mavor. March 10th.

5,981. "Improvements in connectors for electric conductors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) March 10th.

5,983. "Improvements in apparatus for starting and controlling electro-motors." B. N. Dadge. March 11th.

5,998. "Improvements in and relating to electro-capillary relays." J. T. Armstrong and A. Obling. March 11th.

6,006. "Improvements in or relating to electric motor-starting and controlling gear." B. C. Williams-Ellis. March 11th.

6,009. "Improvements in the treatment of diseases by means of electrolysis." G. L. Hogan. March 11th.

6,013. "Improvements in a synchronous motor." G. Meller. March 11th

6,030. "Improvements in and connected with telephone systems." G. E Parker and M. A. Adam. March 11th.

6,038. "Improvements in dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) March 11th.

6,040. "Improvements in electric arc lamps." H. C. Levis. (The General Electric Co., United States.) March 11th.

6,041. "Improvements in electric arc lamps." H. C. Levis. (The General Electric Co., United States.) March 11th.

6,042. "Improvements in electric arc lamps." H. C. Levis. (The General Electric Co., United States.) March 11th.

6,076. "Improvements in telephone receivers which may also be used as telephone transmitters." A. Marr. March 12th.

6,104. "Improvements in electric contact-breakers or tremblers." J. C. Fuller and G. Fuller. March 12th.

6,110. "Improvements in and relating to electric arc lamps." C. E. Foster, E. R. Grote and M. V. Ely. March 12th.

6,117. "Improved construction of clip of holder for electric fuse wires and their insulator casings." M. Pulvermacher. March 12th.

6,126. "Improvements in variable speed dynamos." H. L. Lynton. March 12th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1902.

Electric Ignition Devices for Explosion Engines. K. von Dreger and R. Friedlander. 22,255. October 13th.

Operating Trolley Line and other Switches. P. H. Dawe. 22,649. October 17th.

Electric Trolley Heads with a Wire Finding Apparatus. J. T. Cherry and E. H. Clive. 22,675. October 18th.

Improved Electric Motor-Car. H. W. Heelmann. 22,705. October 18th.

Alternate Current Motors. V. A. Fynn. 22,712. October 18th.

Electric Switches. A. P. Zain. 22,732. October 18th.

Bonding Tramway and Railway Rails for the Purpose of Electrical Connections. H. M. Bigwood and H. M. Bigwood. 22,760. October 20th.

1903.

Electric Storage Battery Plates. O. Imray. (C. Potter.) 23,490. October 29th.

Electrical Measuring Instruments. Chamberlain & Hookham, Ltd., and J. F. Watts. 143. January 3rd.

Electrodes for Accumulators. A. Meygret. 1,676. January 22rd.

Electric Fittings. A. E. Woodyer and E. W. Mayner. 3,957.

Electric Arc Lamps. F. M. Lewis. 4,557. February 26th.

Electrically Igniting Miners' Safety Lamps. W. Best. 4,618. February 27th.

Storage Batteries. F. A. Feldkamp. 9,571. April 28th.

Electric Arc Lamps. J. O. Girdlestone and C. F. G. Thorkelin. 22,582. October 19th.

Railroad Joints for Electric Railways. S. E. Page. (Weber Railway Joint Manufacturing Co.) 23,121. October 26th.

Electrical Clutch and Brake Mechanism. A. P. Steckel. 23,557. October 30th.

Appliances for Electrically Controlling Lifts. J. Richmond and P. F. Carey. 174. January 3rd.

Means for Promoting Electric Discharges Across a Dielectric Gap in a Circuit. A. Williams. 175. January 3rd.

Electrically Operated Bells. M. H. Barber and G. H. Larmuth. 159. January 3rd.

Storage Batteries. T. A. Edison. 822. January 6th.

Method of Regulating Electric Motors. J. G. V. Lang. 329. January 6th.

Electric Measuring Instruments. The British Thomson-Houston Co., Ltd., and F. Holden. 702. January 10th.